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Chapter 3

CHROMITE DEPOSITS OF SHASTA, TEHAMA, TRINITY, AND HUMBOLDT COUNTIES, CALIFORNIA

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CHROMITE DEPOSITS OF SHASTA, TEHAMA, TRINITY, AND HUMBOLDT COUNTIES, CALIFORNIA †

By F. G. Wells * and H. E. Hawkes **

OUTLINE OF REPORT

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CHROMITE DEPOSITS OF SHASTA, TEHAMA, TRINITY, AND HUMBOLDT COUNTIES, CALIFORNIA †—Continued

OUTLINE OF REPORT

Illustrations

ABSTRACT

This report is a synthesis of data relating to the chromite deposits of Shasta, Tehama, Trinity, and Humboldt Counties in the Klamath Mountains and northern Coast Ranges of northwestern California. The data are from the files of the U.S. Geological Survey and the California Division of Mines and Geology. The area consists chiefly of folded strata of Paleozoic and Mesozoic ages which were intruded by abundant ultramafic and other igneous rocks.

In this area the chromite deposits, both disseminated and massive, are closely associated with dunite.

Production of chromite ore has been reported from 112 properties in this area. Fewer than 10 of these have yielded 1,000 or more long tons. The total production as of 1957 was about 50,000 long tons of ore, mostly of metallurgical grade. Individual deposits of disseminated ore within the report area have yielded no more than a few thousand long tons of concentrates or hand-cobbed product.

About one-half of the total production has come from Shasta County, and most of this was massive ore. Little or no chromite was exposed in the workings in Shasta County at the time of examination. In Tehama County 17,270 long tons of chromite had been shipped by the end of 1957. Trinity County has yielded 4,568 long tons of chromite. Half of this was concentrated from disseminated ore, and the remainder consisted of massive chromite in small lots of less than 300 long tons mined from many scattered deposits. Humboldt County has yielded 3,990 long tons of chromite.

INTRODUCTION

Geography

This report describes the chromite deposits of Shasta, Tehama, Trinity, and Humboldt Counties in California. Within these counties, the occurrence of chromite deposits is nearly restricted to the Klamath Mountains (Fig. 1). The major exception is a cluster of deposits in western Tehama County, located in the easternmost part of the northern Coast Ranges.

The southern Klamath Mountains and northern Coast Ranges are rugged mountainous areas. The northern part is dominated by the glaciated peaks of the high ranges, such as the Trinity and Salmon Mountains, and the south-central part by the Yolla Bolly Mountains; all are part of the Klamath Mountains system. The mountains of the Coast Ranges, in the southern part of the area, lie to the west and lap around the southern end of the Klamath Mountains, and generally are lower in altitude.

Federal, State, and County highways serve the more populous areas along the eastern and western margins of the report area; U.S. Highway 299 and State Highway 36 traverse the intervening mountains. In addition, forest, logging, and mine roads extend into parts of the mountains. There are, however, areas as large as two townships which have no roads. Most of the secondary roads are unsurfaced, and some of these are virtually impassable when wet and muddy. During periods of heavy snow in winter, even the surfaced roads are impassable where they cross the high ridges. The main line of the Southern Pacific Railroad follows the valley of the Sacramento River along the east side of the report area. In the west the Northwestern Pacific Railroad follows the valley of the Eel River to Eureka in the coastal area. Most of the chromite deposits are remote from the railways, and ore must be hauled by truck for considerable distances to railheads.

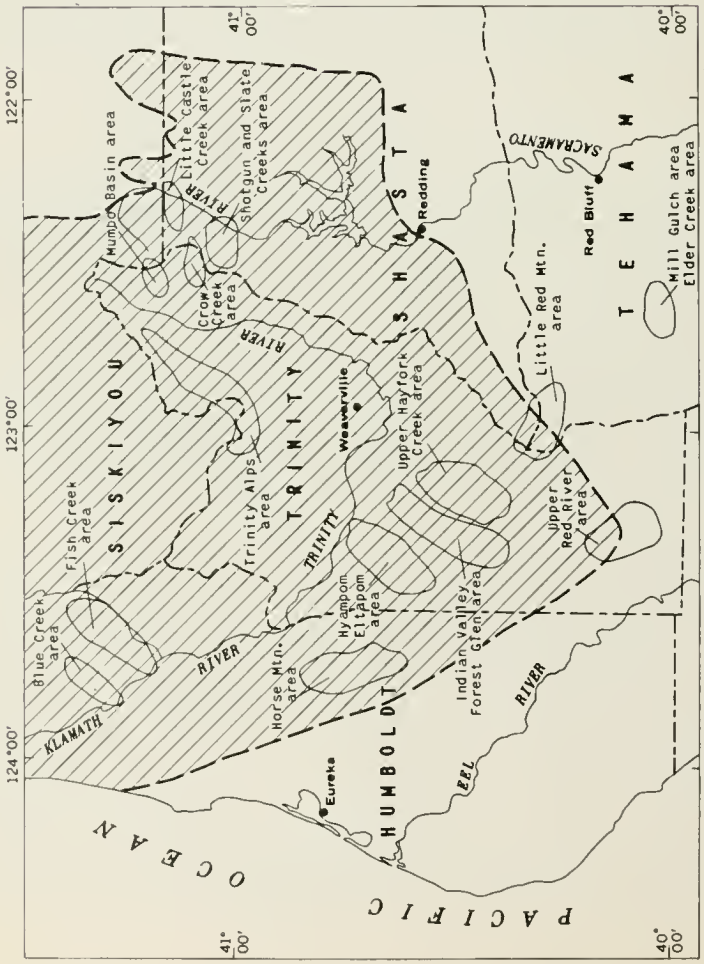


Figure 1. Index map of northwestern California, showing the Klamath Mountains and the areas described in this report.

Except for the coastal belt, which has a mild humid climate, the region has dry hot summers and wet mild winters. This generalization is, of course, modified by altitude. The high northern part of Trinity County has severe winters and is covered with snow that in places persists until late May. In the remainder of the region, however, mining can be carried on throughout the year, although surface workings are difficult to maintain, and hauling is difficult during wet weather. Water is available in all the larger gulches, but the supply is scarce on the tops and upper slopes of the ridges during the late summer and fall. Most of the region is forested and supports a large logging industry. Timbers for mining are readily obtained either from standing trees or from the numerous sawmills.

Scope of Report and Acknowledgments

As part of a nationwide investigation of strategic minerals, the Geological Survey, U.S. Department of the Interior, made extensive field studies of chromite deposits in California during the period 1938–1945. These studies were carried on under the direction of F. G. Wells. Priority was given to the deposits and areas that either seemed to have the greatest production potential or where mining was in progress. Thus, important deposits on Little Castle Creek, Shasta County, were periodically visited, and were mapped by H. E. Hawkes. G. A. Rynearson (1946, p. 191–210) mapped and published a report on the important deposits on North Elder Creek, Tehama County. In the summer of 1942, Rynearson made a systematic reconnaissance of the chromite deposits in Trinity County, but no systematic survey was made of the deposits in Shasta, Tehama, and Humboldt Counties. At times during the period 1946–1951, Wells made a few additional observations in the region. Other geologists who have worked on this project are Gordon Bell, F. W. Cater, Jr., F. W. Gros, R. T. Littleton, J. S. Livermore, P. W. Richards, and D. P. Wheeler, Jr.

This chapter of Bulletin 134 was prepared by F. G. Wells and H. E. Hawkes, who used all available unpublished material in the files of the Geological Survey. The files of the California Division of Mines and Geology, U.S. Bureau of Mines production records, and published sources were also used. References to this material for each deposit are given in tables 4, 8, and 11. The tables include not only the data gathered prior to 1945, but also some that has been collected subsequently. Statements regarding production or reserve figures are dated and are not necessarily valid as of the publication date of this bulletin.

Many persons have contributed generously of their time and provided much valuable information during the various phases of the investigation. Especially helpful were Manley Brown, J. K. Remsen, Philip Munko, and McLaughlin and Applegarth and Associates.

GEOLOGY

General Features

Diller's (1906) classic report on the geology of the Redding quadrangle is the basic report on the geology of the Klamath Mountains. The major part of a geologic map of the Weaverville quadrangle prepared by Diller and Ferguson was published by Ferguson (1912, pl. 2) in his report on the gold lodes of the Weaverville quadrangle. Hinds

(1933, pl. 1) published a map of a larger area in the Trinity River basin. Reports by Kinkel, Hall, and Albers (1956) and Albers and Robertson (1962) describe parts of the same area in greater detail but do not greatly modify the broader features of Diller's maps. Manning and Ogle (1950) reported on the Blue Lake quadrangle, Humboldt County. Irwin (1960) has made a reconnaissance map of the Klamath Mountains and northern Coast Ranges showing the major lithic and stratigraphic units. [Ed. note: Since this manuscript was submitted the Ukiah (1960), Redding (1962) and Weed (1964) sheets of the Geologic map of California were issued by the Division of Mines and Geology with all available geology of the area at a scale of 1:250,000.]

The Klamath Mountains geologic province includes all the northern part of the report area, and extends southward into the central part of the area with diminishing width (Fig. 1). Apparently, it is a southward-plunging asymmetric anticlinorium of Paleozoic and Mesozoic marine sedimentary and volcanic rocks. The rocks generally strike north-northeast on the east limb and slightly west of north on the west limb. The core of the anticlinorium is a complex of granitoid rocks with included pendants of schist and gneiss. Earlier writers (Hershey, 1901, p. 225–245; Hinds, 1933, p. 77–122) have classified these metamorphic rocks as Precambrian, but there is no reason to consider them to be older than early Paleozoic, and, in part, they probably are as young as Mesozoic. Volcanism appears to have been most active during the early Devonian, throughout much of the Triassic, and at intervals during the Jurassic. Although there is much evidence of pre-Jurassic folding in the northern Klamath Mountains, and some within the area under consideration, the first clearly defined major orogeny is the Nevadan at the close of the Jurassic and the beginning of the Cretaceous. Ultramafic and granitoid rocks were intruded at this time.

Parts of western Tehama, southern Trinity, and southwestern Humboldt Counties are underlain by Franciscan and Knoxville sediments of Jurassic-Cretaceous age, which generally strike north or northwest. Ultramafic rocks intrude the Jurassic rocks but nowhere are observed cutting Cretaceous or Tertiary sediments.

Ultramafic Rocks

Chromite occurs as an accessory mineral in both unaltered and serpentinized ultramafic rocks. The investigations by the Geological Survey since 1938 indicate that in the ultramafic rocks of folded belts, important primary concentrations of chromite occur only in dunite, a variety of ultramafic rock consisting of more than 95 percent olivine. Recognition of this fact has proved helpful in searching for and exploiting chromite deposits.

Lithology

Unaltered ultramafic rocks are composed chiefly of olivine and pyroxene with little or no feldspar, and with accessory chromite or related spinel minerals. Those without feldspar are commonest and are known by the group name peridotite. Masses of peridotite generally are partially or even completely serpentinized, as olivine and pyroxene are readily altered to the various serpentine minerals. Geologists and laymen alike frequently call these rocks serpentine. The writers, how-

ever, prefer to reserve the term serpentine to denote ultramafic rocks so altered that their original character cannot be determined by visual inspection. The term peridotite is used to denote both the unaltered rocks and those that still resemble the original rocks, even though they are completely serpentinized.

Peridotite can be differentiated into several varieties on the basis of the mineral composition. The olivine-rich variety containing more than 95 percent olivine is called dunite, whereas the pyroxene-rich variety containing more than 95 percent pyroxene is called pyroxenite. Rocks containing intermediate proportions of olivine and pyroxene are called saxonite,* wehrlite, or lherzolite depending on whether the contained pyroxene is enstatite, diallage, or both. Saxonite is by far the most abundant variety in the area of this report, but dunite and pyroxenite also are common; wehrlite and lherzolite have been reported but are not common.

Dunite, saxonite, and pyroxenite are distinguished from one another in the field mainly by the amount of pyroxene. Weathered dunite is recognized by its uniform fine-grained texture. It weathers to a smooth buff or buckskin-colored surface. Enstatite (pyroxene) is generally coarser grained than olivine and can usually be readily distinguished in the fresh rock by its prominent cleavage. Enstatite usually alters to a variety of chlorite known as bastite, which retains the characteristic pyroxene cleavage and resists weathering to a greater extent than the product of serpentinization of olivine. Thus weathered surfaces of moderately altered saxonite are characteristically studded with silvery or bronze-colored bastite pseudomorphs.

Unserpentinized saxonite and dunite are watery green in color and translucent on freshly broken surfaces. The groundmass is most commonly even-grained. Weathering of both rocks liberates iron oxide, and as pyroxene is higher in iron content, saxonite and pyroxenite usually are reddish brown to rust colored whereas dunite is usually buff.

Alteration

The ultramafic bodies commonly are completely altered to serpentine along fractures, faults, shear zones, and contacts, and although parts of a few bodies are unaltered, most of them are partially or completely serpentinized throughout. Except where sheared, the serpentine commonly retains the structure and texture of the original ultramafic rock, but broken surfaces are dark greenish black to black with a fine sugary texture. Where sheared, the serpentine is broken into greenish-gray to honey-colored flakes and lenticular lumps with polished surfaces. The thin flakes are commonly translucent. If shearing has been intense, the rock readily disintegrates into small scale-like particles and is sometimes called slickentite, a rock which has little strength and slumps readily.

Structure

Areas underlain by ultramafic rocks are conspicuous in the field. They can be recognized readily even at considerable distance because of the relative paucity of vegetation and the characteristic reddish-

* Such rocks also have been called harzburgite, but the name saxonite is the earlier term and has priority.

colored blocks of weathered peridotite which crop out abundantly through the thin rust-colored soil. The bodies of ultramafic rock in this region range in size from masses only a few square yards in area to one of about 700 square miles. The outcrop of the southern end of this large body covers more than 200 square miles in northern Shasta and Trinity Counties. The outcrop areas of ultramafic rocks are shown on Plate 19 (pocket).

Although the structure of none of these bodies has been worked out completely, most of them appear to be tabular. Several occur along unconformities and are called "sheets." Based on the size of their exposures, it is reasonable to assume that the thickness of some of these bodies is in excess of 4,000 feet. Where the sheets occur between steeply dipping formations their outcrop pattern is long and narrow. They may share the folded structure of the enclosing formations as they apparently do at the south end of the Trinity Mountains sheet west of La Moine. It can be demonstrated that the great Josephine Mountain sheet of Del Norte County (Wells, Cater, and Rynearson, 1946, p. 10) and Josephine County, Oregon (Wells, Hotz, and Cater, 1949, p. 9-10), has been folded with the enclosing formations. The same is probably true of the Trinity Mountains sheet. The sheet has been intricately intruded by quartz diorite and has a complex map pattern.

A few peridotite bodies are transgressive and should be called dikes. Others occur along faults and may have intruded along the faults or may have been faulted into their present site.

CHROMIUM MINERALS

Chromite

Chromite is the only chromium-bearing mineral that occurs in sufficient quantity to be a commercial source of chromium. Furthermore, the mineral itself has chemical and physical properties that make it valuable as a refractory material. Most chromite is iron-black in color with submetallic to almost vitreous luster; chromite that has been sheared or crushed is brownish-black to chocolate in color, and has a dull luster if finely crushed. It has a specific gravity between 4 and 5, a hardness of about 5, and can be scratched readily with a knife. Chromite has a variable magnetic susceptibility dependent on the iron content. The brown color of the mineral powder distinguishes magnetic chromite from magnetite.

Chromite is a member of the spinel group of minerals and crystallizes in the isometric system. Stevens (1944, p. 1-34) has shown chromite to be an isomorphic compound of the six end members—magnesiochromite ($MgO.Cr_2O_3$), ferrochromite ($FeO.Cr_2O_3$), spinel ($MgO.Al_2O_3$), hercynite ($FeO.Al_2O_3$), magnesioferrite ($MgO.Fe_2O_3$), and magnetite ($FeO.Fe_2O_3$). Chromite from different deposits therefore may have widely different compositions owing to different combinations and proportions of the end members. Even in an individual deposit, chromite may vary in composition, but probably within a rather restricted range. The pure mineral may contain less than 30 percent to more than 60 percent chromic oxide.

Chromium-Bearing Silicates

Chromium-bearing silicate minerals are found in small amounts in the ore but are of no commercial value. They include uvarovite, the chromium garnet, and kammererite, the chromium chlorite. Chromium-bearing pyroxene was not recognized in the report area.

Uvarovite is emerald green, has vitreous luster, and is harder than quartz. It forms incrustations of tiny perfectly formed dodecahedra on joint surfaces in massive ore. It is found in small quantities in chromite from many areas in Shasta County and is particularly abundant in the Little Castle Creek area.

Kammererite is soft, micaceous, and lavender to pink in color. It is common as small plates in chromite and contiguous gangue; where well developed, it forms hexagonal plates or books of plates.

Unlike chromite, which is of primary igneous origin and cognate with the enveloping dunite, these other minerals of chromium were formed later than the ultramafic rocks and are of hydrothermal origin.

Disseminated Ore

Microscopic and larger grains of chromite are scattered through the dunite bodies much as any accessory mineral in any igneous rock. The rock is referred to as disseminated ore if the chromite grains are abundant enough to be of economic value. In some places, the chromite grains may be so abundant as to make up 80 percent or more of the rock, thereby becoming what is classified as massive chromite. The aggregations of chromite grains often occur as small wisps, dots, or clusters of layers, and commonly grade sharply outward into leaner ore or barren dunite. Generally they are lenticular or tabular in form but they may be quite irregular. Regularly layered chromite is common, and nodular structures are found in small amounts at many places. Excellent examples are found at the Coggins mine.

In low-grade disseminated ore, the chromite grains are commonly euhedral to subhedral. The latter have angular outline and one or more rectilinear faces. When grains are closely spaced, however, anhedral bounded forms are apt to predominate, and some of the chromite looks as though it had been shattered and the cracks filled with a fine silicate mineral. Layers of chromite separated by layers containing only a few scattered grains of chromite in dunite are commonly observed.

The shapes of bodies of disseminated ore generally are too irregular to be simply defined; the boundaries of such ore zones ("assay walls") must be determined by assay. Distinctly elongate masses of ore generally are parallel to the strike of the peridotite body; if ellipsoidal, the longest axis is commonly parallel to other linear elements in the mass. Although the disseminated ore always occurs in dunite, the localization and shape of the dunite bodies is unpredictable.

Massive Ore

Massive ore differs from disseminated ore in that it consists largely of chromite with little or no interstitial silicates. Bodies of massive ore, however, may include irregular masses of disseminated ore or may have a thin rind, rarely as much as a foot wide, of disseminated chromite. The chromite grains in the typical massive ore are rather coarse, ranging from 1 mm to 1 cm in diameter and commonly being several milli-

meters. Bodies of massive ore are so variable in form that one is often hard pressed to find a suitable term to describe their shape. Those that are tabular with tapering edges can aptly be called lenses, a common term in mining; those bounded by irregular and rounded surfaces can be called pods, a term that includes a multitude of shapes; and elongated bodies with irregular and rounded edges can be called stringers. Such thin tabular bodies often have the appearance of veins. Careful study of these veinlike structures does not reveal the internal structures characteristic of true hydrothermal veins. Their origin probably is best explained by the injection of chromite-rich mush along planes of weakness.

Size

In California, deposits of massive ore that have been mined ranged from only a few pounds to almost 20,000 tons, and deposits of disseminated ore range from a few pounds to more than 300,000 tons. The largest individual body of massive ore yet found in California is the Little Castle Creek mine in Shasta County, which yielded approximately 15,000 long tons of ore.

Table 1 shows the number and distribution of deposits in various size groups. The figures represent properties rather than individual deposits. However, the production data from individual properties rarely are accurate, as production is generally listed under shipper.

Table 1. Distribution of 104 chromite deposits by size range, and county.

Size Range (long tons)	Number of deposits				Percent of total number of deposits
	Shasta	Tehama	Trinity	Humboldt	
0–50	10	8	21	5	42.3
50–100	4	5	5	8	21.2
100–500	5	5	7	4	20.2
500–1,000	2	5	--	--	6.7
1,000	4	3	1	2	9.6
Total	25	26	34	19	100.0

Grade

Very few complete chemical analyses of chromite from this area are available. The best data available are the assays of the chromite shipped to the U. S. General Services Administration stockpile at Grants Pass, Oregon (Table 2).

Only two complete analyses of chromite from these counties have been made in the laboratory of the Geological Survey (Rynearson, 1946, p. 201). Both are of carefully concentrated chromite of disseminated ore from North Elder Creek, Tehama County. The chromic oxide contents are 55.86 percent and 54.86 percent, and the chromium to iron ratios are 3.44 and 3.08. The assays shown in Table 2 indicate little about the chromic oxide content of the pure chromite, but illustrate that a concentrate or hand-cobbed product of 45 percent or more chromic oxide can be made from the deposits throughout the area. The

Table 2. Range of analyses of chromite from Shasta, Tehama, Trinity, and Humboldt Counties shipped to G.S.A. stockpile, Grants Pass, Oregon, from 1952 to 1957 (analyst, Abbot A. Hanks).

Property name	Cr_2O_3 (percent)	Fe (percent)	Cr/Fe (ratio)
HUMBOLDT COUNTY			
White Cedar	44.0–47.2	12.3–12.6	2.4–2.6
Lassic Peak	46.9	13.1	2.5
Blue Creek	44.7–46.6	10.4	2.9–3.1
Pyramid	43.3–47.0	10.1–10.8	2.8–3.2
Binder 1	45.5	10.9	2.9
SHASTA COUNTY			
Forest Queen	42.9	13.8	2.1
Cascade	43.7–44.1	10.3–12.5	2.4 2.9
Little Castle Creek	43.1–45.6	11.1–12.2	2.6–2.7
Little Castle Creek	43.9–46.5	10.0–11.8	2.7–2.8
Little Castle Creek	45.6	12.2	2.6
TEHAMA COUNTY			
State School Lands	43.6–49.3	11.0–12.8	2.3–2.8
Blue Sky (Lucky Star)	44.1–49.9	10.0–12.4	2.8–3.1
Elder Creek	44.8–47.9	11.9–12.5	2.6
Kleinsorge Group	42.3–47.4	10.8–12.6	2.6–2.7
Black Chrome	48.0–50.8	12.9–13.8	2.5–2.6
TRINITY COUNTY			
Happy-Go-Lucky	44.4–46.4	11.7 12.3	2.5–2.8
Crow Creek Group	42.0	11.0	2.6
Redskin	42.7–46.9	11.0–13.6	2.5–2.6
Starr-Bee	42.1–45.1	11.3–14.1	2.2–2.5
Shamrock	43.2	10.1	2.9

assays of ore from Tehama County indicate that the chromite ores from the North Elder Creek area probably are closely comparable to the chromite of the complete analyses.

Production

Accurate production figures probably are the most useful means of appraising the future possibilities of a former producer. In general, old workings are completely caved, dumps yield little pertinent information, and commonly there are no maps of the deposits. Although we still lack a reliable guide for predicting the presence of ore bodies without surface expression, it is probable that a large part of any future production will come from ore that remains in or near known deposits. Almost without exception, the production of chromite during the period 1938-1950 came from deposits listed by Diller (1922, p. 3, 4) at the end of World War I. To this purpose, many data on the production of individual deposits will be given in the various sections of this report. However, the data differ in reliability. The number of tons in any shipment can be determined with relative certainty from stockpile and other records, but the sources of the chromite combined into shipments commonly are confused.

Production data listed by deposits are given in tabular form in the sections devoted to separate counties. The data have been obtained from all available sources, including published and unpublished records and first-hand information furnished by mine owners and operators and others familiar with the mining operations. These production figures

represent the most accurate data available but should not be considered as official production tonnages.

SHASTA COUNTY

Shasta County, approximately 3860 square miles in area, extends from the lava fields of the Cascade Range westward across the head of the Sacramento Valley into the Klamath Mountains, and to the south into the northern end of the Coast Ranges. Its western boundary is the divide between the drainage of the Sacramento and Trinity Rivers. Only the part within the Klamath Mountains contains chromite deposits. All the area except about 400 square miles of the Sacramento Valley is mountainous and very rugged. Some peaks in the Trinity Mountains attain an altitude of 7,000 feet or more.

The Sacramento River, the master stream of the region, flows south across the western part of the area. The main line of the Southern Pacific Railroad and U.S. Highway 99 follow its open valley in the south and narrow canyon in the north. Redding, the county seat and supply center of the region, has a population of 59,648 (census 1960). Most of the county, however, is difficult of access and is served by only a few dirt roads that are all but impassable during wet weather. The Sacramento Valley has a mild semiarid climate with hot dry summers and cool rainy winters. The mountainous areas have cool summers with little rain, and cold snowy winters which are quite unsuited to open-cut mining and hauling.

Geology

Pre-Tertiary rocks are exposed in the northwestern and western part of the county within the Klamath Mountains and probably underlie the younger volcanic rocks of the Cascade Range to the east. The stratiform rocks are largely marine sediments but include volcanic flows, tuffs, and breccias; some have been metamorphosed to crystalline schist. The assemblage, which ranges in age from early Paleozoic to the late Mesozoic, has been folded and faulted, first during Paleozoic time, later in the early Mesozoic, and again and more intensely during the Late Jurassic and Early Cretaceous (Diller, 1906, p. 9). The axis of the early folding was north-northeast. Hence, the Paleozoic rocks in the northern part of the county have a northeasterly strike. As the ultramafic bodies in this area are rudely conformable, they may have been intruded during Jurassic time. The Klamath Mountains were planated during Cretaceous time, and the Cretaceous rocks and younger formations were laid down on this resulting surface of low relief. They conceal the ultramafic rocks in which the chromite deposits are found.

The principal peridotite body in Shasta County is situated in the northwest corner of the county. It is anticlinal in structure and appears to be tabular and at least rudely conformable to the overlying sedimentary rocks. The upper contact of this sheet dips eastward and southward along the eastern and southern boundaries. This structure has been complicated by faulting and by intrusions of younger igneous rocks that range in composition from gabbro to dacite. The largest of these intrusive bodies is many square miles in extent. Castle Crags, an imposing high massif of light-gray granodiorite that dominates the landscape west of Dunsmuir, is a good example.

Good exposures of the peridotite are found in the steep gulches that are cut by short streams flowing eastward into the Sacramento River and westward into the Trinity River. In general, the peridotite shows little sign of serpentinization in outcrop, and it breaks into large irregular blocks. Some of the peridotite is almost unaltered, as on Little Castle Creek. Most of the peridotite is saxonite or lherzolite. An unusual dunite body occurs at Little Castle Creek; it appears to be pyroxenite but actually is dunite composed of olivine crystals that show two perfect cleavages (Hawkes, 1946, p. 279).

Most of the chromite deposits, and all the large ones that have been mined, are near the eastern contact of the peridotite. This may be due either to the greater accessibility of this area, or to the distribution of the chromite within the sheet. The large deposits, consisting of massive ore, occur at low altitudes, usually within 1½ miles of the eastern contact and without exception within 4 miles of it. Small deposits of less than 1,000 short tons of chromite of the disseminated type have been found more than 7 miles from the eastern contact and at high altitudes. The disseminated deposits seem to be near the roof of the peridotite sheet and the massive ore near the base, but the evidence is not conclusive.

The chromite deposits are grouped into the Little Castle Creek and the Shotgun Creek areas.

History and Production

The first reported production from Shasta County was approximately 3,000 tons of chromite which was mined before 1896 from pods in the gulch of Shotgun Creek. The production to 1957 was about 26,500 long tons (Table 3). The bulk of the production has come from the Little Castle Creek mine, and the remainder was from mines that were operated in response to the high price of chromite during World Wars I and II.

The claims or mines and prospects in Shasta County are listed alphabetically in Table 4 and are shown on Plate 19.

In the Little Castle Creek area, chromite was discovered during the latter part of the last century, when the ridge southwest of the present Little Castle Creek mine was prospected to locate the source of abundant chromite float. Operations on a larger scale began in 1906, when L. H. Brown discovered the Main ore body of the Little Castle Creek mine. Between 1906 and 1915, Brown developed the deposit by open-cut and underground workings, and reported shipments of 2,891 long tons (compiled from records at the State Mining Bureau). In 1915, the property was bought by the California Chrome Company, who operated the mine under the management of J. R. Van Fleet. The ore was mined by block caving. An aerial tramway led from the mine to the valley floor, where it was connected to the main line of the Southern Pacific Railroad by a narrow-gauge railway. According to records of the State Mining Bureau, a total of 15,000 tons was mined from 1906 to 1917. Following the exhaustion of the large body of massive ore, L. H. Brown started a tunnel from the west side of the open cut to tap the Main ore body at a lower level but abandoned it at a distance of 80 feet from the portal. After World War I, the mineral rights lapsed and were acquired by Mrs. Margaret Graham when she located a homestead in

Table 3. Chromite production from Shasta County, California, as of 1957 (in long tons).

Property	Pre-1916	1916	1917	1918	1928	1935	1937	1941	1942	1943	1951	1952	1953	1954	1955	1957	Total
Beegum No. 10				655													655
Cadillac group																28	28
Cascade															15		15
Costa Ranch												71	26				97
Davis group				89													89
Deer Lick									18								18
Forest Queen group	57		1,002	510	134				84	11		70	7	5			1,880
Hearst lease	60																60
Hoy		100	89														189
Little Castle Creek	2,891	*12,200		381			48	*400	311	462			25				16,718
Lucky Strike									19	12							31
Montrose Mill									128	579							707
North Fork Queen																6	6
Round Bottom									432	39							471
Shotgun Creek (Noble Electric)	2,855			136													2,991
Stenberg, F. O.								70									70
Sunset										17							17
Taylor, L. D.									42								42
Unknown	2,193		5	32		25				8	120	71	8				2,462
Total	8,056	12,300	1,096	1,803	134	25	48	470	1,034	1,128	120	212	66	5	15	34	26,546

* Approximate figure.

Table 4. Alphabetical list of chromite mines and prospects in Shasta County, California, giving old names, locations, owners, and operators.

Name of mine or prospect	Map no.	Location (MDM) Sec.	T.	R.	Name of owner (O) or shipper (S)	Source of data	Class[1] by production
Beegum No. 10						U. S. B. M.[2]	B
Cadillac						U. S. B. M.[2]	C
Cantonwine (Hilt lease)	10	23	37N	5W		Diller, J. S., 1918, unp.	
Cascade					W. F. Floyd (O, S)	U. S. B. M.[2]	C
Costa Ranch					Castle Crags Chrome Co. (S, 1952) Ashland Mining Co. (S, 1953)	U. S. B. M.[2]	C
County Line claim (Wildcat Creek)	11	35	37N	6W	A. D. Grafton (O)	Wells, F. G., 1941, unp.	D
Davis group (Ida Chrome group)	9	13, 23, 24, 25	37N	5W	J. A. Davis (O)	Bradley and others, 1918, p. 181	D
Deer Lick							C
Forest Queen group (Gray Eagle, North Star No. 1, Bull Dog, Mammoth, Black Bird, and Rattlesnake)	8	NW 22	37N	5W	Antone Orsini (O)	Bradley and others, 1918, p. 181; O'Brien, 1943, p. 327; Diller, J. S. 1918, unp; and Wells, F. G., 1939, unp.	A
Hearst lease	2	NE 3	38N	4W	Mrs. P. A. Hearst (O) F. J. Solinsky (S)	Bradley and others, 1918, p. 183	C
Hoy	7	SW 15	37N	5W	Southern Pacific RR (O) William Auspech and E. K. Hoy (Lessor)	Diller, J. S., 1918, unp.	B
Little Castle Creek (Cal. Chrome, Brown, and Union Chrome, Creek prospect, and Hearst property)	1	NW 2	38N	4W	L. H. Brown (O); California Chrome Co. (S, 1918); Mrs. Margaret Grahaan (O); Manley Brown (S, 1943)	Bradley and others, 1918, p 183 188; Allen, 1941, p. 131 132; O'Brien, 1943, p. 321; Diller, 1919, p. 28-30; Hawkes, H. E., 1942, unp; Rynearson, G. A., 1944, unp; and Wells, F. G., 1940, unp.	A
Lone Pine	4	SW 13	37N	5W	E. A. Curtis (O)	Bradley and others, 1918, p. 188	
Lucky Strike	3	7	38N	4W	Philip Munko and L. D. Taylor (O) F. S. Pollock (S)	O'Brien, 1943, p. 327 and Ureka, M. R., 1943, unp.	C
Miles and Westover	6	SE 14, 34	37N	5W	D. E. Miles and William Westover (O)	Bradley and others, 1918, p. 188 and Diller, J. S., 1918, unp.	
Montrose Mill							B
North Fork Queen						U. S. B. M.[2]	C
Round Bottom		5	26N	10W	Dave and Leland Pierson (S)	California Division of Mines files[2]	B
Shotgun Creek (Gill, Priem, and Dougherty group and Noble Electric Steel Co.)	5	13, 14, 23 and 24	37N	5W	Thomas Jones 1896 (O); C. F. Dougherty (1943)	Diller, J. S., 1906, Harder 1909.	A
Stenberg, F. D.					F. Stenberg (O)	California Division of Mines files[2]	C
Sunset						California Division of Mines files[2]	C
Taylor, L. D.							C
Winchester claims						California Division of Mines files[2]	C
Williamson					C. Williamson	California Division of Mines files[2]	C

[1] A—1,000 long tons or more; B—150–1,000 long tons; C—Less than 150 long tons; D—No ore shipped.
[2] From field investigation by R. A. Matthews, 1957

the Little Castle Creek valley. M. M. Brown, son of the original discoverer, leased the mineral rights from Mrs. Graham in 1937. From the spring of 1941 to February 1942, the L. J. Buck Company subleased the property and mined about 400 long tons of marginal ore from the Third-level ore body. M. M. Brown mined 773 long tons from the Upper ore body in the latter part of 1942 and in 1943, when mining ceased.

The Coggins mine in Siskiyou County is on the steep slope immediately across the valley from the Little Castle Creek mine. Between 1916 and 1921 A. L. Coggins, the owner, shipped 1,727 long tons of ore. In 1937 the Rustless Mining Corp. of Sacramento leased the property from the owner and did underground development work on the East low-grade zone and the West ore body. Work was resumed in June 1942 when J. K. Remsen of Grants Pass, Oregon, subleased the mine from

Table 5. Chromite production from the Little Castle Creek area, Shasta and Siskiyou Counties, California, as of 1957.

	Shipments (long tons)	Grade (in percent Cr_2O_3)	Remarks
Little Castle Creek mine			
1906	71	Not known	
1907	223		Operated by L. H. Brown.
1908	250		Production from main ore body.
1909	286		
1910	205		
1911	93		
1912	147		
1913	255		
1914	506		
1915	855		
1916	[1]12,100	45–48	Operated by California Chrome Co. Production from main ore body. Figure derived by difference between 15,000 tons (total production to 1917) and 2,891 (production before 1916).
1918	381	Not known	
1937	48		
1941	[1]400	Not known	Operated by L. J. Buck Co. Production from third-level ore body.
1942	311	Not known	Operated by M. M. Brown.
1943	462		Production from upper ore bodies.
1953	25		
Total	[1]16,618		
Hearst property			
	[1]60		Two carloads of load ore were shipped prior to 1918.
Coggins mine (Siskiyou County)			
1916	893		Operated by A. L. Coggins.
1917	446	38	Production from east ore body.
1918	275		
1920	58	40	
1921	55		
1939	200		Operated by Rustless Mining Corp. Production from west ore body.
1942	1,002	38	Operated by J. K. Remsen.
1943	1 009	38	Production from west ore body.
Total	3,938		
Grand total	[1]20,616		

[1] Approximate figure.

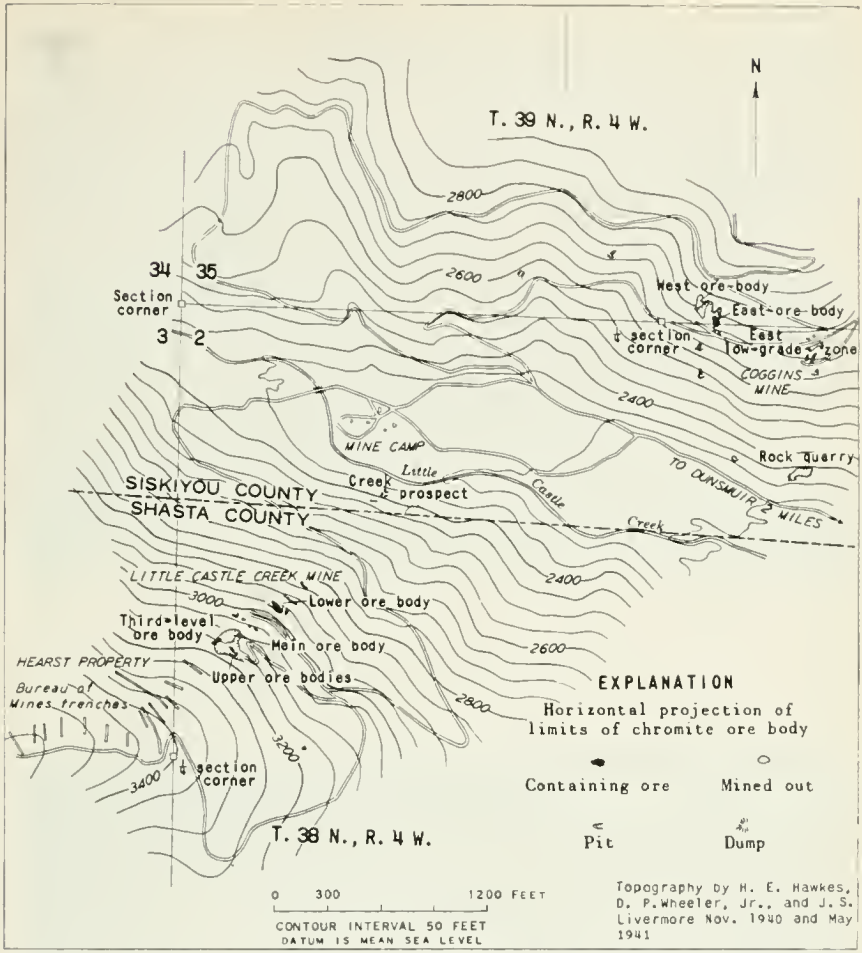


Figure 2. Topographic map of the Little Castle Creek chromite area, Shasta and Siskiyou Counties, California.

the Rustless Mining Corp. When mining ceased on April 20, 1943, Ramsen had shipped 2,211 long tons from the West ore body.

The U.S. Bureau of Mines (Matson, 1949) explored the Little Castle Creek mine in 1941 and the Coggins mine in 1942–43. The results of this work have been published (Shattuck and Ricker, 1949). Hawkes, and later Ryncarson, advised Matson and Shattuck during the exploration, and Hawkes (1951) made a magnetic survey of an area southwest of the Little Castle Creek mine.

The total production of chromite ore from the Little Castle Creek area as of 1957 is about 20,000 long tons. The published records of production from the Creek area are in conflict. Figures given in U.S. Geological Survey Mineral Resources reports for the years before 1920 do not agree with those given in California Mining Bureau bulletins. L.

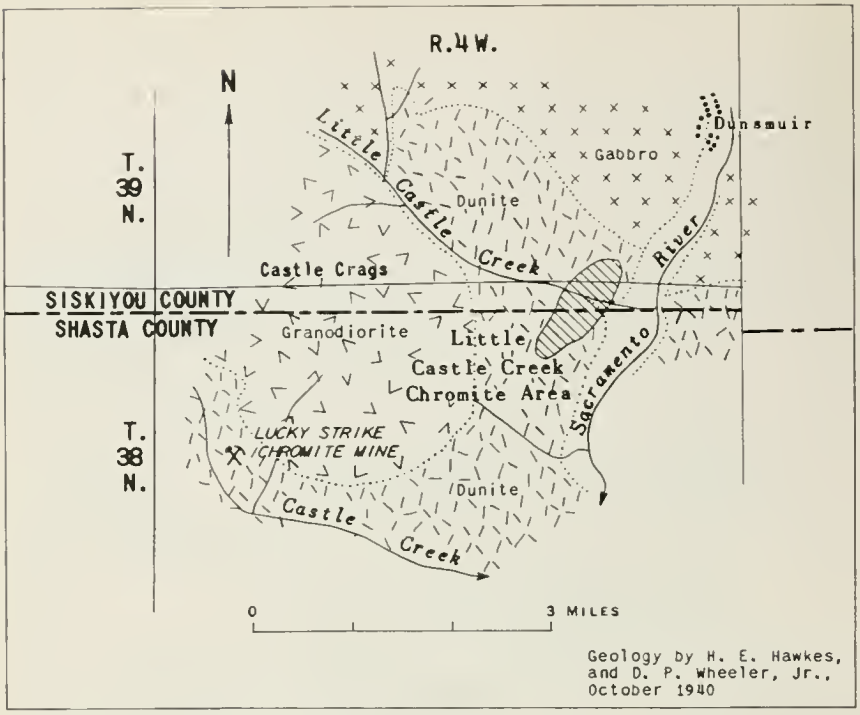


Figure 3. Geologic map of the area southwest of Dunsmuir, California.

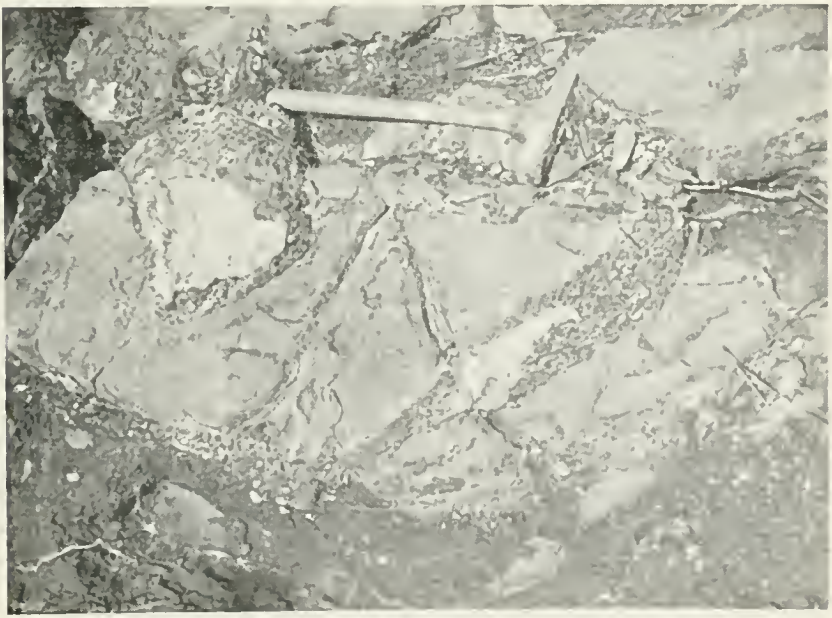
H. Brown, M. M. Brown, Arthur Coggins, and the staff of the Rustless Mining Corp. furnished information which has been collated with the published data. The results, which are substantially correct, are given in Table 5.

Little Castle Creek Area

The Little Castle Creek area includes the lower part of the steep gulch of Little Castle Creek, a short eastward-flowing tributary of the Sacramento River, in the northeastern part of T. 38 N., R. 4 W., MDM. Three properties, the Coggins in Siskiyou County and the Little Castle Creek (Brown) mines, and the Hearst property, are on the steep sides of the gulch (Fig. 2). The shipping point is Dunsmuir, 2½ miles to the north on the Southern Pacific Railroad. A geologic map of the area is shown in Figure 3.

The ultramafic rocks of the Little Castle Creek area are exceptionally fresh; dunite which is more than 20 percent serpentinized is uncommon. Intense serpentinization was seen only near contacts of the dunite with granodiorite of the Castle Crags pluton or along local zones of shearing. Two types of serpentine minerals were noted: (1) felts of fine-grained antigorite laths filling fractures, and (2) large blades of either antigorite or chlorite, following crystal directions in the olivine. Secondary magnetite occurs in veinlets or irregular streaks and is interpreted as a by-product of the serpentinization of olivine. Carbonates are associated with magnetite in some of the veinlets.

Phatas 1A, B. Irregular masses of chromite nodules in dunite, in smooth-weathering massive dunite bodies, exposed in the walls of caved workings, Caggins mine. The long axes of the nodules are at an angle to the boundaries of the chromite-rich masses.



Although in some places the abundance of chromite increases gradationally from sparse dissemination to massive ore, in general, the transition is sharp. At places in the Little Castle Creek mine, the transition zone is only a few feet in width; at places it is less than an inch or even a sharp line. Banded ore is found at the Lower ore body on the Little Castle Creek property. Bodies of disseminated ore occur on the Hearst and Coggins properties, but no massive chromite is associated with them. All the chromite in the East ore body of the Coggins mine consists of a closely packed mass of ellipsoidal nodules of chromite ranging in size from a quarter of an inch to an inch, in a matrix of antigorite and chromium chlorite.

Geology

The country rock for the chromite deposits is an unusual variety of dunite in which the olivine shows perfect cleavage as described in detail by Hawkes (1946). This cleavage has confused previous workers who believed the rock to consist mostly of pyroxene which characteristically exhibits two cleavages. Diller (1917) states. "The country rock of the chromite ore body is in part peridotite, but chiefly pyroxenite, which exhibits large cleavage surfaces often several feet in extent."

On the south slopes of Little Castle Creek valley the olivine crystals of the dunite have a common orientation, so that the cleavage of the olivine defines a very definite planar structure. This planar structure strikes northwest at all places where it was seen, and dips vertically or steeply north, nearly at right angles to the attitude of the chromite bodies.

Accessory chromite, and to a lesser extent magnetite, is present as grains throughout the dunite in proportions as great as 0.3 percent. The grains commonly are located in the interfaces of olivine crystals. At one place fresh dunite contains several percent by volume of disseminated magnetite.

The Little Castle Creek dunite body is bounded on the north by a large body of gabbro (Fig. 3), which is composed of pyroxene and plagioclase with local hornblende, biotite, potassium feldspar, and quartz. Wide variations in both composition and grain size are common over short distances within the body of the gabbro.

About 1½ miles west of the chromite deposits, a body of nearly white coarse-grained porphyritic rock forms Castle Crags, a spectacular massif of pinnacles and spires. It ranges in composition from granodiorite through quartz diorite to diorite. The dominant feldspar is plagioclase which occurs both as large phenocrysts as much as 1 inch long and as small crystals in the finer grained groundmass. Phenocrysts of quartz and potassium feldspar are likewise present. Accessory minerals of the groundmass are biotite and green hornblende. The granodiorite is finer grained at its contact. Complete serpentinization is a characteristic of the ultramafic rocks where they adjoin granodiorite and appears to result from hydrothermal activity coupled with shearing.

Evidence of the magnitude of displacement along faults within the dunite body is difficult to find because of the homogeneous character of the rock. Diller (1916, p. 30) reports a transverse fault cutting the Main ore body of the Little Castle Creek mine. He mentions that although there is 5 feet of displacement on the first level of the mine,

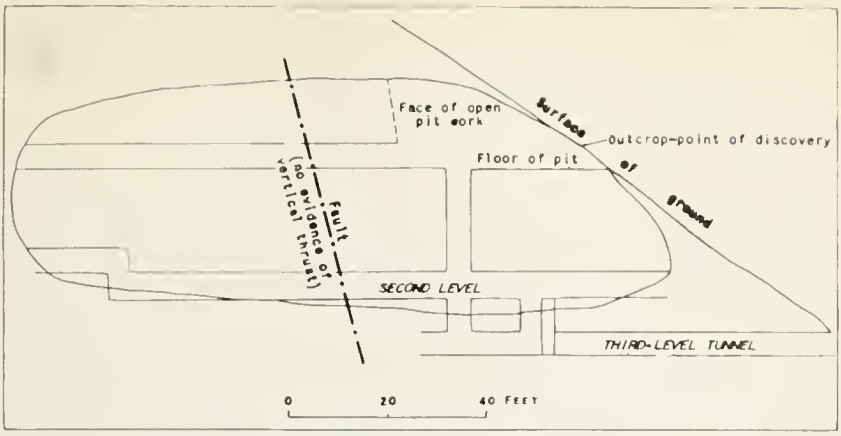


Figure 4. Longitudinal section of Little Castle Creek mine, Shasta County, California.

this displacement has decreased to zero on the second level 30 feet below. The Footwall fault at the West ore body of the Coggins mine apparently has truncated the ore body, but the magnitude and direction of displacement are not known. Intricate systems of serpentinized joints, breccia zones, and slickenside surfaces are prominent in all the underground workings. These structures show no simple systematic arrangement. The magnitude of the displacement along these breaks was negligible wherever determined.

Little Castle Creek Mine (1) *

The property was held by the Brown interests when last examined in 1943. It comprises four claims on the south side of the Little Castle Creek valley, in sec. 2, T. 38 N., R. 4 W. MDM (Fig. 2). The Little Castle Creek mine consists of several ore bodies (Plate 20). The old workings in the Main ore body have caved and were inaccessible when the property was visited by the Geological Survey in 1940. Diller (1917, p. 29) included a map and section of the workings, which are shown in this report in Plate 20 and Figure 4 and 5.

Main Ore Body. The Main ore body was keel shaped and on the first level was 40 feet wide, 54 feet high, and 46 feet long in a direction N. 40° E.—roughly parallel to the eastern contact of the peridotite body. On the second level 30 feet below, the length had increased to nearly 160 feet, and the width and height had decreased by one-half. It was bounded on the northeast by a zone of sheared serpentine, probably a fault.

After preliminary work by open-cut and exploratory tunnels, an adit was driven under the ore body, and ore was mined by block caving. The ore caved well, and the process was economically feasible, but mining was hazardous owing to slippery joint surfaces in the ore and country rock. M. M. Brown stated (oral communication, November 1942) that labor difficulties arose as a result of unsafe mining

* Numbers following mine names refer to map, Plate 19.

conditions, so that it became necessary to shut down the mine before the ore had been completely removed. The ore that remains is presumably at the southwest end of the old workings and above the present third-level tunnel.

Third-Level Ore Body. More recent (1950) workings consisted of a tunnel under the old workings on the third level, driven in an attempt to explore the reported extension of the ore zone southward into the hill. Chromite was found in these workings at a distance of 180 feet from the portal and southwest of the southernmost workings of the original ore body (Plate 20). The deposit is exposed in the tunnel for a length of 60 feet, and has a maximum width of 20 feet. It strikes northeast, essentially parallel to the Main ore body. Some of the ore along the east side of the ore body, adjoining the fault shown on Plate 20, was of shipping grade. In 1941, the L. J. Buck Co. mined and shipped about 400 tons from the Third-level ore body; data on the grade of these shipments are not available. One grab sample of ore collected by the Geological Survey in 1940 contained 38.98 percent Cr_2O_3. Chromite concentrated from this sample contained 54.03 percent Cr_2O_3; 17.81 percent Fe; and had a Cr:Fe ratio of 2.08 to 1. The largest part of the ore in the third-level ore body was too low in grade to meet specifications. Much of the low-grade material consists of horizontal sheets of chromite, ranging from a fraction of an inch to a foot in thickness, interlayered with barren dunite from which it cannot be easily separated by hand.

The bottom, the two walls, and the northeast end of the deposit at tunnel level have been found, but no exploration has been done to delimit the top or the southwest end, or to determine whether a direct connection exists with the Main ore body. In 1942 the most promising prospecting ground lay above the present workings, where a continuation or recurrence of the massive chromite of the Main ore body may be found. Indicated reserves in the Third-level ore body were about 380 tons of 20 percent to 25 percent Cr_2O_3 ore, as exploration to 1942 had not proved a vertical dimension of more than 12 feet.

Upper Ore Bodies. A lenticular ore body about 8 feet wide and 50 feet long, and two smaller irregular deposits have been found at the surface southeast of the slumped area over the Main ore body. At the time of examination in 1942, slide material covered the bedrock so that ore was not exposed. The outlines of the ore bodies shown on Plate 20 are from a survey made by J. R. Shattuck of the U.S. Bureau of Mines in November 1942. The ore in one carload shipped to the Yreka stockpile contained 37.16 percent Cr_2O_3; 11.35 percent Fe; 12.47 percent SiO_2; and had a chromium-iron ratio of 2.2 to 1. Based on the dimensions of the ore bodies shown on Shattuck's map, the indicated reserves are about 300 long tons.

Lower Ore Body. At a level 85 feet below the third level, a deposit of disseminated ore 65 feet long and 25 feet wide was developed in an open pit before World War I. In 1943 the pit was largely filled with waste and slide material, so that ore is exposed only at a few scattered spots around the edge of the body. The exposed ore probably contains an average of more than 20 percent Cr_2O_3. A small tonnage of ore is reported to have been mined and shipped during World War I, so presumably some parts of the deposit contained shipping-grade ore.

The disseminated ore shows a prominent linear structure plunging from 20° to 25° to the northwest. If the lineation is parallel with the long axis of the body, the average depth of ore may be about 8 feet. This depth of ore over the exposed length of 65 feet and average width of 15 feet gives about 750 long tons of inferred reserves. The grade will probably not be more than 25 percent Cr_2O_3.

Creek Prospect

An exposure of chromite has been excavated on the old trail to the Main ore body about 50 feet above the level of Little Castle Creek (Fig. 2). The ore consists of angular fragments of nodular chromite from a few inches to a foot in diameter, scattered in a matrix of unaltered dunite. Fifteen percent of an area about 7 feet square in the face of the cut is ore; the remaining 85 percent is dunite. If the ore contains 35 percent Cr_2O_3, the material across a mining width would contain about 5 percent Cr_2O_3. Considerable trenching was done both above and below the main pit, but nothing of any importance was found.

Hearst Property (2)*

Chromite float is found in an area southwest of the Little Castle Creek mine, chiefly in sec. 3, T. 38 N., R. 4 W. MDM. Brown states (oral communication, 1942) that about two railway carloads of high-grade float chromite were gathered from the ridge top 1,000 feet southwest of the Little Castle Creek mine. An extensive program of trenching and prospecting was unsuccessful in finding the source of the float. In 1941 the Bureau of Mines trenched the area with a bulldozer but found only one small body of lean disseminated chromite.

Coggins Mine

In 1943 the property was held by A. L. Coggins, who leased it to the Rustless Mining Corp. of Sacramento. They in turn subleased it to J. K. Remsen of Grants Pass, Oregon. The workings are in Siskiyou County, across Little Castle Creek from the Little Castle Creek mine, so the production statistics are given in Table 5. The property straddles the line between Tps. 38 and 39 N., R. 4 W. MDM, lying in secs. 2 and 35, respectively (Fig. 2). It is accessible most of the year by a Forest Service road that crosses the property 1¼ miles from U.S. Highway 99. A line through the ore area on the Little Castle Creek property connecting the Coggins main workings trends N. 84° W. Three important bodies of chromite are on the property: the West ore body, the East ore body, and the East low-grade zone. Between 1916 and 1921, A. L. Coggins, the owner, mined from the East ore body 1,727 long tons of ore reported to contain 38 to 40 percent Cr_2O_3 (Coggins, oral communication). Analyses of 35 carload lots averaged 38 to 47 percent Cr_2O_3, 12.03 percent SiO_2, and 2.4 to 1 Cr Fe ratio. Coggins reported the presence of additional ore, but none was seen in the caved workings in 1940–45.

West Ore Body. Coggins discovered the West ore body during World War I. He ran a few exploratory tunnels into it, but was unable to ship any ore before the market collapsed. Between 1937 and 1945,

* Number refers to identification on map, Plate 19.

the Rustless Mining Corp. shipped 2,211 long tons of ore mined from this ore body.

The West ore body was an essentially horizontal, irregular, tabular mass of chromite about 130 feet long from north to south, an average width of 30 feet, and ranged in thickness from a few inches to 15 feet. The plan and sections in Plate 21 show its size and shape. The horizontal attitude allowed mining of the entire ore body from a single level, with subsidiary workings 6 feet above and 6 feet below the tunnel level. The deposit is bounded in most places either by sharp contacts with the serpentine, or by steeply dipping shear zones. At the north end, the sheet thins to a few inches, and profitable mining was not possible. A fault which strikes northeast and dips 60° W. cuts off the ore to the east.

The ore in the West ore body consisted of closely packed elongate pellets or nodules ranging from a quarter of an inch to an inch in length, the long axes of which are parallel and plunge to the southwest. The ore body is in sharp contact with the barren dunite. Moreover, the nodules of the ore body are transected along the plane of contact. The easterly and southeasterly margin of the West ore body was mined out in 1917. A slumped area above the workings and the margin of an open cut are shown in Plate 21. Along the margin of the open cut, clusters and short veins of nodular chromite were seen in the dunite walls of the caved area in 1943. These veins reveal the sharp barren walls of the constituent nodular chromite and the fact that the long axes of the parallel chromite nodules pitch at an angle to the walls of the vein.

East Ore Body. Most of the 1,727 tons which Coggins shipped between 1916 and 1921 came from the East ore body. The original size and shape of the deposit is inferred from a few exposures of ore in the walls of the pits, and from diamond-drill information. Apparently the body dipped about 55° to the south. The ore, similar in appearance to that of the West ore body, is made up of elongated nodules of massive chromite in a matrix of serpentine. The plan of the mine shows inferred structural contours on the footwall (Plate 21). Coggins mined most of the ore from the surface, but also sank a shaft and ran a short drift to develop the ore beneath the open pit. These workings are caved, and except for two drill holes which passed through old mine timbers, no reliable information is available as to their exact location. The probable position of the shaft and tunnel is shown on the map (Plate 21). A total of 275 tons remain above the old workings if the thickness of the ore body remains the same down to Coggins' old drift and if none of the ore was stoped out above the drift level. Additional ore may occur below the drift level; some of it may be marginal. Two holes drilled by the U.S. Bureau of Mines (Shattuck and Ricker, 1949) intersected the East ore body, but no attempt was made by the operators to mine the drilled ore. In diamond-drill hole No. 9S the core from 25.0 to 30.5 feet in depth contained 39.38 percent Cr_2O_3; in diamond-drill hole No. 4S, the core from 21.0 to 28.0 feet in depth contained 19.85 percent Cr_2O_3; from 28.0 to 38.0 feet it contained 35.27 percent Cr_2O_3; and from 38.0 to 42.0 feet it contained 26.87 percent Cr_2O_3. Analyses are by the U.S. Bureau of Mines.

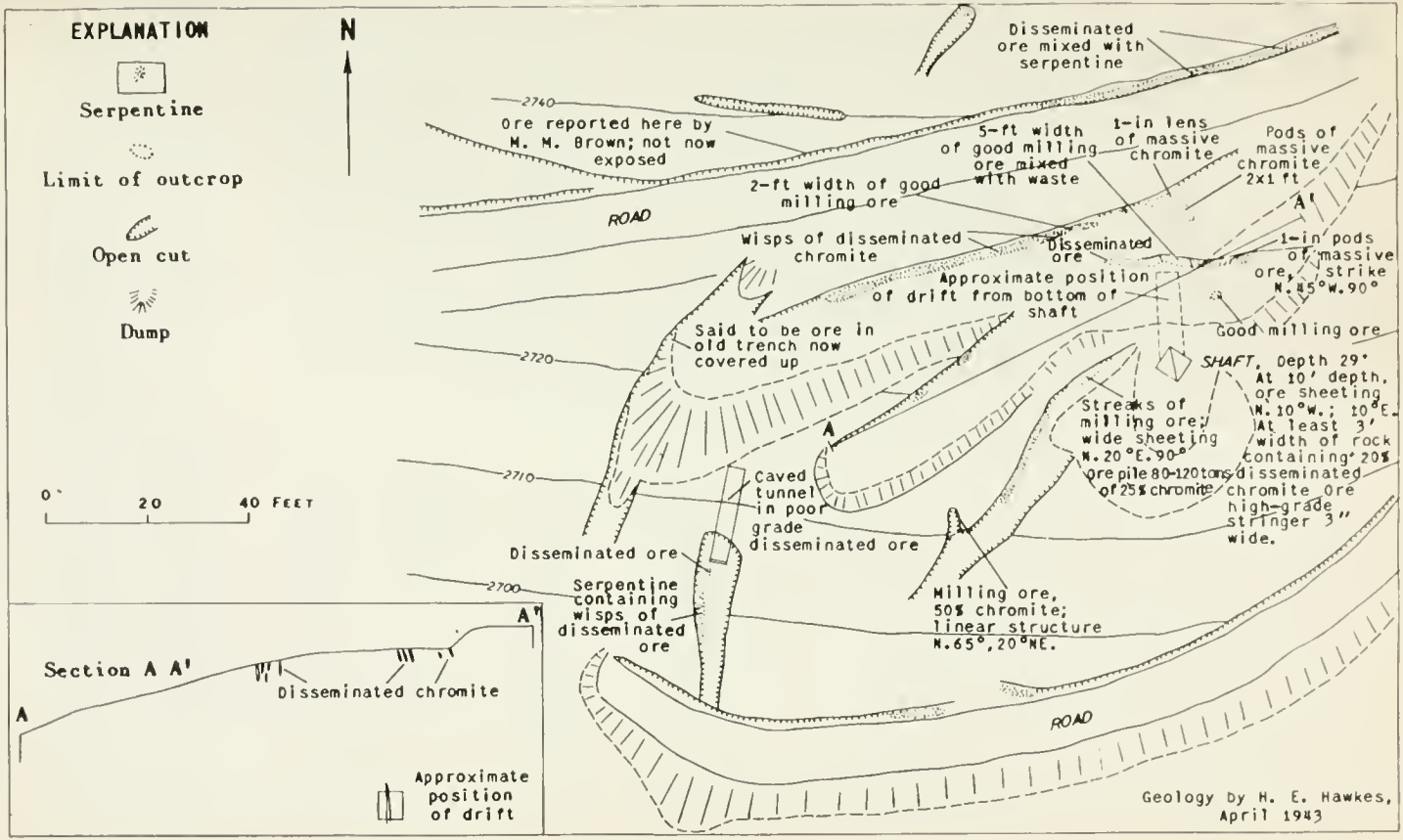


Figure 5. Plan and section of East low-grade zone, Coggins mine, Little Castle Creek area.

East Low-Grade Zone. The East low-grade zone is an area of scattered irregular bodies of disseminated chromite about 600 feet east of the main workings of the Coggins mine and 50 feet lower in altitude. Disseminated chromite is exposed over a width of 90 feet and a length of 180 feet. The Rustless Mining Corp. sank a shaft 29 feet in the most promising exposure and drifted 15 feet north from the bottom of the shaft (Fig. 5). About 80 tons of ore was taken out of these workings and piled on the dump. In 1943, water filled the shaft to within 20 feet of the surface so that the drift could not be examined. The ore body probably dipped steeply to vertical. Ore is exposed on the surface for a strike length of 30 feet and maximum width of 5 feet. According to R. S. Mason (oral communication, 1942) of the Rustless Mining Corp., the average width of the ore body in the shaft and drift is 1 foot. Indicated ore based on a 2-foot average width is 145 long tons containing 12 to 15 percent Cr_2O_3. An exploratory hole should be drilled to determine the continuity of the body below the drift. The surface and underground workings should be sampled prior to exploratory drilling. Eighty feet southwest of the shaft a thin, low-grade tabular body of ore dips about 45° E. The Rustless Mining Corp. drove an 18-foot tunnel into this body, but found no increase in the grade or thickness. Nine other occurrences of disseminated ore were seen within the zone, but none was more than a few feet in longest dimension and most were low grade. Mason said that analyses made by the Rustless Mining Corp. indicate that the iron content of the chromite is variable and generally high, so that the ore, even if concentrated, might not meet specifications for metallurgical ore. Unless ore containing less than 15 percent Cr_2O_3 can be milled profitably, the East low-grade zone has little promise of production.

Shotgun Creek Area

The Shotgun Creek area is about 6 miles from north to south and about 9 miles from east to west. Its eastern edge lies in the valley of the Sacramento River. The area is rugged, and road construction is difficult. A steep dirt mountain road leaves U.S. Highway 99 3½ miles north of La Moine and climbs to the top of the divide. Another road, which in 1943 was barely passable, leads up the valley of Slate Creek from La Moine to the crest of the range. At Delta, a county road follows the gulch of Dog Creek to its headwaters and then climbs over the divide and descends to the Trinity River; at the divide, a Forest Service road leaves the county road and follows the crest for about 6 miles north to Slate Mountain. Dunsmuir, 10 miles north of Shotgun Creek, is the commercial center for the area, but ore can be shipped from La Moine.

Shotgun Creek Mine (5)

The largest producer of chromite in the Shotgun Creek area is the Shotgun Creek mine. Other names for this mine are the Gill, Priem, and Dougherty group, and the Noble Electric Steel Co. property, according to C. F. Dougherty (oral communication, 1943). Thomas Jones discovered a large pod of chromite projecting above the ground between the forks of Shotgun Creek and shipped 3,000 tons of ore prior to 1896 when Dougherty inherited the property. This agrees roughly with

the Tenth Annual Report (1890) of the California Mining Bureau, which states that 2,000 tons of chromite were mined at this property during 1889, and that the ore was shipped to Baltimore, Maryland, realizing a royalty of $3.00 per ton. The deposit also was mined in 1913, 1914, and 1918.

The property is about 1 mile west of U.S. Highway 99. Access to the property is by road up Shotgun Creek, however, the road is largely washed out. When the property was visited in 1943, all the workings were caved and little could be learned about the ore deposits. However, the property was described by Diller (1906) and Harder (1909, p. 766–767), and the following is a synthesis of their reports.

The chromite deposits occur over a vertical range of about 600 feet in an ill-defined shear zone that trends N. 40° E. across the steep gulches of the north and south forks of Shotgun Creek, crossing from section 13 to section 23 near the common corner of secs. 13, 14, 23, and 24, T. 37 N., R. 5 W. MDM. The shear zone is vertical, and its trend is essentially parallel to a contact about 1½ miles to the east, between peridotite and slate of Mississippian age. Five lenticular pods of ore ranging in size from 200 to 1,500 tons were found in this zone, distributed over a length of 250 yards. The largest pod, the first discovered, was connected by narrow seams of chromite to the smaller pods to the southwest. The pods were mined by means of a 50-foot adit driven N. 30° W. from the creek, and a winze sunk from the end of the tunnel to a depth of 30 feet or more.

About 400 tons of good ore was mined from another pod by means of a short tunnel on the south side of the south fork of the creek. Another deposit on top of the spur within the forks yielded 200 tons.

The ore is lustrous and generally lies against polished surfaces of serpentine. Hence, in most places it separates easily and cleanly from the serpentine, but in some places it adheres firmly.

The record of production from this property is incomplete and confusing. As previously stated, 2,000 tons of ore were shipped in 1889. The records of the California Mining Bureau show the following:

Year	*Production (short tons)*	*Producer*
1900	140	Sylvester Hall, C. F. Dougherty
1901	130	C. F. Dougherty
1902	315	Do
1903	150	Do
1904	98	
1905	20	
1906	80	C. F. Dougherty, F. P. Brown, and Primm
Total	933	

In 1918 the Bureau of Mines listed a production of 136 long tons from the Shotgun Creek mine. Assuming that the production listed for 1889 was in short tons, the total verifiable production is 2,855 long tons.

Production from other properties nearby may have been credited to the Shotgun Creek mine. Among such properties are the L. C. Hoy (7), Miles and Westover (6), Lone Pine (4), Davis group (9), and Cantonwine (10).

Forest Queen Mine (8)

The Forest Queen (Gray Eagle) mine is 1½ miles west of the Shotgun Creek mine and about 1,000 feet higher. It is in NW¼ sec. 22, T. 37 N., R. 5 W. MDM. The claims cover much of the ridge and south slope, south of the south fork of Shotgun Creek. Chromite was shipped from this property in 1908, 1911, and in 1916 when the owners, Charles Morton and Leon Boyer, sold it to the Manganese Co. of California. Anton Orsini and S. Gallogos mined and shipped ore from 1928 to 1931, and Anton Orsini shipped ore in 1942 and 1943. The Montrose Mining and Milling Co. leased the property and hauled the ore then on the dump to their mill on Castle Creek. Total recorded production through 1943 is 1,880 long tons (Table 3). Ore was probably mined in addition to that shown in the production figures.

In 1939 the property consisted of seven claims as follows: North Star No. 1, Union Forest, Forest Queen, Bull Dog, Mammoth, Black Bird, and Rattlesnake. The old workings were in bad condition and no chromite was seen in place. Mr. Orsini (oral communication, 1939) said that chromite crops out on the property, but we did not succeed in finding the outcrops during the examination. The dunite in the tunnel is broken into large blocks, and the ground is heavy. Bradley and others (1918, p. 182) described the property as follows:

"Irregular shaped ore bodies occurring in peridotite have been opened by inclines and tunnels. The main workings consisted of a 50′ cross-cut at an elevation of 4420′, to an ore body striking N. 40° E. and pitching 45° NW. The ore had been stoped for 150′ in length and 100′ in depth. The body varied from 0′–4′ in width. The stopes are connected by a 60′ incline shaft just west of the tunnel entrance.

"At an elevation of 4450′ is a 50′ tunnel with a 16′ incline showing ore from 12″ to 18″ wide and from 6′ to 10′ high. The ore appeared to run about 50% Cr_2O_3.

"The Jumbo, or lower tunnel, at an elevation of 4400′, had been run N. 33° W. for a distance of 135′. A drift on the 30′ level had been run east for 15′ and one on the 40′ level had been run east for 25′. Only about 15 tons of ore were said to have been taken from the first drift and none from the second."

From this description, it is evident that the ore is parallel both to the ore zone at the Shotgun Creek mine and to the peridotite contact 3½ miles to the east. The ore, however, dips to the northwest. It seems to be mainly of the massive type, but with a little disseminated spotted ore. Uvarovite and kammererite were common along fracture surfaces in the ore. A shipment of 11.61 long tons of ore to the Metals Reserve stockpile at Anderson, California, during 1943 contained 35.43 percent Cr_2O_3, 11.63 percent Fe, and had a Cr/Fe ratio of 2.08.

County Line Claim (Wildcat Creek) (11)

The County Line claim, held by A. D. Grafton, is in sec. 35, T. 37 N., R. 6 W. MDM, just below the crest of a ridge at an altitude of 4,400 feet. It is about 1 mile beyond the end of a road that leads across the Sacramento Mountains northward from the county road. The country rock is saxonite. In 1941, chromite was not seen in place, but about 3 tons of translucent chromite had been stockpiled. Some uvarovite was seen on fracture surfaces. The soil on the ridge is thin but contains many grains and small lumps of chromite. No significant structures or indications of ore were seen in the outcrops of peridotite.

TEHAMA COUNTY

Tehama County is an area of approximately 2,000 square miles. It extends from the Sierra Nevada across the Sacramento Valley to the crest of the Coast Ranges. Altitudes range from 300 feet in the Sacramento Valley to more than 6,000 feet in the Sierra Nevada and Klamath Mountains. The climate is mild, and, except in the mountainous areas, good open-cut mining conditions prevail throughout the year.

Red Bluff, the county seat and largest city, is on the Sacramento River about the center of the county. Once it was the head of navigation on the Sacramento River, and now is on the main line of the Southern Pacific Railroad. U.S. Highways 99E and 99W join at Red Bluff and continue north; State Highway 36 leads west across the Sacramento Valley and across the Coast Ranges.

Geology

Tertiary continental deposits cover all the older rocks in which chromite might occur in the Sacramento Valley. Eastward-dipping sedimentary rocks of late Jurassic to Cretaceous age border the Klamath Mountains. In outcrop these rocks trend north. They are separated from the older rocks of the southern Klamath Mountains and adjacent parts of the Coast Ranges to the west by a long, tabular, north trending body of peridotite, the Elder Creek mass, which in places attains a thickness of more than 2 miles. The Elder Creek mass terminates to the north at the South Fork of Cottonwood Creek.

Another large body of peridotite, the Beegum Creek body, crops out in the northwest corner of the county and extends more than 6 miles in a northwesterly direction into Trinity County. It lies within Paleozoic and Triassic metasedimentary and metavolcanic rocks. It is irregular in shape, and much of it has been sheared to slickentite. Many thousands of long tons of lump ore and concentrates have been mined from the Elder Creek and Beegum Creek peridotite masses, but ore bodies as large as the Little Castle Creek or Coggins have not been found.

History and Production

The earliest record of production of chromite was in 1886 when the Tehama Consolidated Chrome Co. located deposits in sec. 16, T. 25 N., R. 7 W. MDM, and mined lenses of high-grade ore from open cuts. Shipments were made by rail to San Francisco and thence by boat to Philadelphia. Hensley and Hazelwood were reported to be working a deposit in secs. 13 and 14, T. 26 N., R. 7 W., MDM, in 1890. Intermittent shipments totaling more than 5,000 long tons were reported in 1899. The properties were then closed and remained idle until World War I in 1915. From 1915 until the collapse of the market in 1918, the Noble Electric Steel Co., the American Refractories, and several other operators produced 3,800 long tons of chromite ore. A mill designed to treat low-grade ores was erected in 1918 but did not get into production. Significant production was resumed in 1942 when F. Y. McLaughlin and G. A. Applegarth obtained leases on secs. 16 and 17, T. 25 N., R. 7 W. MDM, and began producing from the Grau mine.

The production from each property or group of properties in Tehama County is listed in Table 6. Production from many deposits was com-

Table 6. Chromite production from Tehama County, California, as of 1957 (in long tons).

Property	Pre-1916	1916	1917	1918	1924	1929	1942	1943	1949	1952	1953	1954	1955	1956	1957	Total
Adams and Maltby				547												547
Alder Creek No. 1													7			7
Apex and Tops															17	17
Bear Cat												5				5
Big Bear														6		6
Black Chrome												16	28			44
Bland (Packsaddle and Boomer)							28									28
Blue Sky (Lucky Star)												[1]155	[2]262	[3]35		452
Cadillac											22					22
Elder Creek (Elder Creek group, North) (Grau, Grau West pit, Hill, Joyce, Mill Gulch, Lower Noble Electric, Upper Noble Electric)				507			940	1,419		54	337		70	85	119	3,531
Hill			402	161												563
Johnson, G. S.		85														85
Kleinsorge group			446	526									32	235	[4]405	1,644
Little Meadow													30			30
(Little Red Mountain group)					[5]188		[5]94	[5]37								319
Lucky Star											231					231
McArthur											27					27
Noble Electric Co. (see North Elder Creek group)	13	1,339	419													1,771
North Fork											78					78
Pine Tree No. 6															23	23
Red Mountain									51							51
River Divide (Mary Ann)												17				17
Seagrave, North Fork										51	17					68
South Elder Creek												7				7
Star group											7					7
State lease						54										54
State School											89	526	59			674
Sunshine (Blue Sky)										34	49					83
Tedoc group			567					4					6			573
Three Point Buck								10								4
Twin Cedars																10
Utah Chrome Co.													35			35
Unknown	5,962		179					32								6,173
Total	5,975	1,424	2,013	1,741	188	34	1,062	1,502	51	139	900	754	542	361	564	17,270

[1] Includes North Fork and River Divide (Mary Ann).
[2] Includes Seagrave, North Fork, River Divide (Mary Ann), Jumbo, McArthur, and Sunshine.
[3] Includes Grau.
[4] Specific mine or mines unknown.

bined under one heading in the old production figures, and it is impossible now to determine the tonnages from individual deposits. Most of the deposits probably yielded less than 200 long tons of lump ore. The occurrences of chromite in Tehama County are listed in Table 7.

Elder Creek Area

Kleinsorge Group (28) *

The Kleinsorge group of mines is in the steep ravine of the Middle Fork of Elder Creek. The property, which is patented ground owned by W. E. Kleinsorge of Sacramento, is within secs. 21, 22, and 27, T. 25 N., R. 7 W. MDM. Chrome ore was discovered on section 27 in 1916, and ore containing 42 percent Cr_2O_3 was mined in 1917 from high-grade pods in talcose serpentine. In 1918, a large tonnage of disseminated ore containing an estimated 6 percent Cr_2O_3 was developed in five open pits, and a mill to concentrate this ore was built and operated at this time. Twenty-two carloads of concentrates of 50 percent Cr_2O_3 reportedly were shipped in 1918. When the property was visited in 1942, the workings were badly caved.

Bradley and others (1918, p. 207) stated, "Small crystals of chromite are disseminated throughout a zone of decomposed serpentine, which is approximately one-fourth of a mile wide, extending north and south for two miles along a precipitous ridge that lies at the head of the middle fork of Elder Creek, about one mile south of the Hill and Noble Electric Company's deposits."

North Elder Creek Group (25)

Grau Mine

The Grau mine is located on two properties. One is in secs. 9, 17, and 21, T. 25 N., R 7 W. MDM, and has been leased by McLaughlin and Applegarth from the Grau Estate and W. E. Kleinsorge. The other is located in sec. 16, T. 25 N., R. 7 W. MDM, and was leased from the State in November 1941. The ore body consists partly of irregular stringers and small pods of nearly massive chromite and partly of disseminated chromite in dunite. Definite arrangement of the pods or layering of the disseminated ore has not been recognized, but the ore body as a whole trends about N. 80° W., and dips about 40° N.

West Pit of Grau Mine

The West Pit of the Grau mine is 800 feet west along the canyon wall from the main workings. It consists of three small pits, two short prospect trenches, and a shallow bulldozer cut. The geology is partly obscured as the rocks are exposed only in the workings and road cuts; elsewhere the bedrock is covered with 3 to 6 feet of talus. The ore is in a small tabular mass of serpentinized dunite enclosed by saxonite. The long dimension of the dunite body strikes about N. 35° W. and dips at a moderate angle to the northeast. By the end of 1957, a total of 3,531 long tons of ore were reported to have been shipped from the Grau property. The reserves of ore as of April 1943 are listed in Table 8.

* Numbers following mine names refer to map, Plate 19.

Table 7. Alphabetical list of chromite mines and prospects in Tehama County, California, giving old names, locations, owners, and operators.

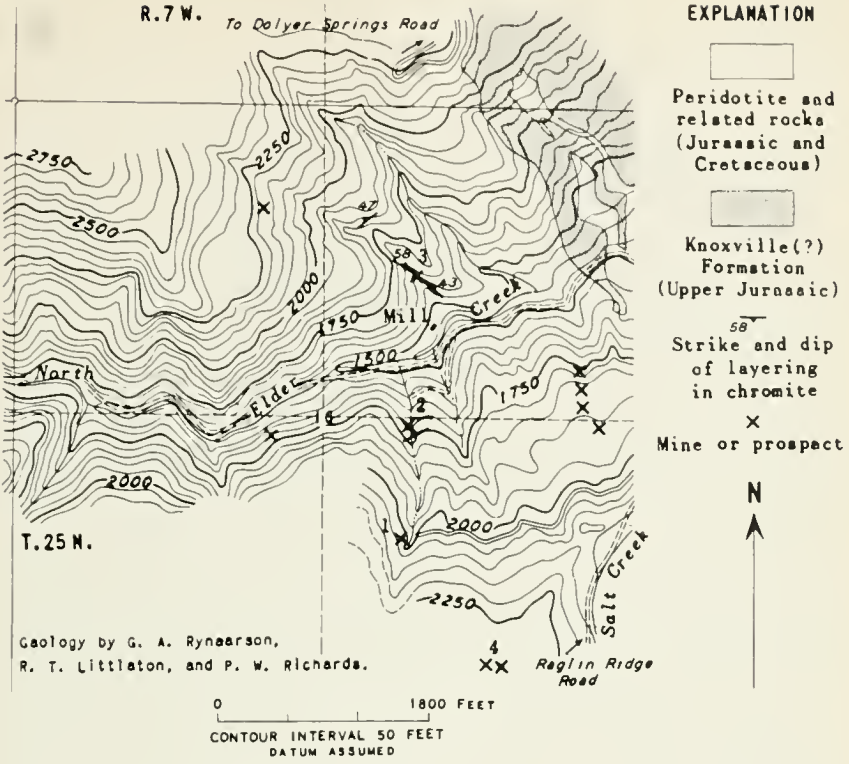
Name of mine or prospect	Map no.	Location (MDM)			Name of owner (O) or shipper (S)	Source of data	Class[1] by production
		Sec.	T.	R.			
Adams and Maltby							B
Alder Creek No. 1					Frank Watson (S)	U. S. B. M.	C
Apex and Tops							C
Bear Cat	15x	2	28N	10W	J. Cherney and P. Magee (S)	U. S. B. M.	C
Big Bear	26x	NE 20	25N	7W	Liston Ehorn (O)	O'Brien, 1946, p. 187	C
Black Chrome					J. H. McKinney and F. Piatt (S)	U. S. B. M., 1954	C
Bland (Packsaddle and Boomer)	19x	N½ 19	28N	10W			--
Bumble Bee	14x	E½ 2	28N	10W			--
Cadillac	12x	34	29N	10W	C. H. Hoffman and J. Hall (S); J. Latin and J. Corny (S), 1953	U. S. B. M.	C
Ehorn group	27						--
Ore Basin		SW 20	25N	7W			--
Valley View		SW 20	25N	7W			--
Elder Creek (see North Elder Creek group)					Elder Creek Mining Co. (S)	U. S. B. M.	C
Johnson, G. S.						California Division of Mines	C
Kleinsorge group	28				W. E. Kleinsorge (O)	Bradley and others, 1918, p. 206, 207	--
Angora		S/2 27	25N	7W			--
Black Beauty		SW 22	25N	7W			--
Climax		S/2 27	25N	7W			--
Milton		SW 27	25N	7W			--
Name unknown		NW 21	25N	7W			--
Name unknown		S/2 21	25N	7W			--
Trilby		S/2 27	25N	7W			--
Little Red Mountain group	13						--
Blue Jay		SW 12	28N	10W			--
Blue Sky		NE 12	28N	10W			--
Jumbo (Red Mountain No. 2)		NW 11	28N	10W	H. T. Moore and H. A. Robinson (O, S)		--
Live Oak		SW 1	28N	10N			--
McArthur and Lucky Star					L. B. Duffin (O)	U. S. B. M., 1956	--
Mogul		S/2 1	28N	10W			--
Name unknown (4th of July, Mary Ann, Southern Pacific lease, and River Divide)		NE 18	28N	9W			--
Panther		SW 7	28N	9W			--
Seagrave (Beegum mine)		SW 12	28N	10W	Western Rock Product Co. and Seagrave Chrome mine (O); H. T. Moore and H. A. Robinson (S)	O'Brien, 1946, p. 187	B

Snowshoe		SE 1	28N	10W			--
Sunshine (Red Mountain No. 3, Pine Grove)		W/2 11	28N	10W			--
McArthur	21x	SE 22	28N	9W			--
North Elder Creek group	25						--
Grau		NE 17	25N	7W	Grau Estate, W. E. Kleinsorge (O), McLaughlin and Applegarth (S)	Rynearson, 1946, p. 203; O'Brien, 1946, p. 187	A
Grau, West pit		NW 17	25N	7W	do	do	A
Hill		SE 16	25N	7W	S. W. Hill (O, S)	Rynearson, 1946, p. 210; Allen, 1941, p. 132	C
Joyce		SW 15	25N	7W			--
Mill Gulch		NE 16	25N	7W	Tehama Consolidated Chrome Co. (S)	Rynearson, 1946, p. 208; O'Brien 1946, p. 188	A
Noble Electric, Lower		SE 16	25N	7W	Noble Electric Steel Co. (S)	Rynearson, 1946, p. 206	--
Noble Electric, Upper		SE 16	25N	7W	do	do	--
Name unknown		15	25N	7W			--
No name		NE 17	25N	7W			--
North Fork							C
Pine Tree No. 6							C
Red Mountain							C
Round Bottom	17x	SE 4	28N	10W	Dave and John Pierson (O); Donald Woodrum (S)	O'Brien, 1943, p. 327	--
South Elder Creek						U. S. B. M., 1954	C
Star Group						U. S. B. M., 1953	C
State lease (State School)	24x	16	25N	7W	Metro Metals (S)	U. S. B. M.	B
Tedoc group	22				Tedoc Mining Co. (O); Agard and Stewart (S)	Bradley and others, 1918, p. 209	B
Dead Pine claim		NW 28	28N	9W			--
Mountain View claim		SE 29	28N	9W			--
Tomshead	23x	E/2 25	27N	9W	J. E. Heslewood (O, S)	Bradley and others, 1918, p. 209	D
Turner group	18						B
Peach, Bucha A		18	28N	10W			--
Twin Cedars		NE 7	28N	10W	Delos Turner (O); William Atwood (S)	Wells, F. G., 1941, unp.	C
Utah Chrome	20x	7	28N	9W	Utah Chrome Co. (S)	U. S. B. M.	C
Zachary group	16						--
Beegum Nos. 3, 4, and 5		2	28N	10W			--
Beegum Nos. 6, 7, and 8		E/2 3	28N	10W			--
Black Jack		E/2 3	28N	10W			--
Redbird		E/2 3	28N	10W	H. A. Robinson (O)		--
Three Point Buck		E/2 3	28N	10W			C

[1] A—1,000 long tons or more; B—150–1,000 long tons; C—Less than 150 long tons; D—No ore shipped.

Table 8. Reserves of chromite deposits in the North Elder Creek group area, Tehama County, California, April 1943 (Rynearson, 1946, table 17).

Mine or area	Concentratiog ore (short tons)					Shipping ore (short tons)				
	Measured	Indicated	Inferred	Total	Percent Cr_2O_3	Measured	Iodicated	Inferred	Total	Percent Cr_2O_3
Grau mine	16,000	7,700	15,400	39,100	10		1,300	2,600	3,900	44
West Pit of Grau mine		4,000	4,000	8,000	8.8	20			20	40
Noble Electric Steel Co. workings:										
Upper		1,000		1,000	10					
Lower		2,900		2,900	10	20	50	20	90	47
Mill Gulch area		27,000	31,000	58,000	11.6					
Low-grade prospect						25		25	50	32
Total	16,000	42,600	50,400	109,000		65	1,350	2,645	4,060	



Deposits described in report

1. Upper workings of Noble Electric Steel Co.
2. Lower workings of Noble Electric Steel Co.
3. Mill Gulch area
4 Hill Mine

Figure 6. North Elder Creek area, Tehama County, California.

Noble Electric Steel Co. Workings

According to Rynearson (1946, p. 206–207):

"Two chromite deposits in the NW¼SE¼ sec. 16 * * * were worked by the Tehama Consolidated Chrome Co. and J. A. Heslewood in the years 1890 to 1898 and by the Noble Electric Steel Co. in the years 1915 to 1918. Both deposits are in a steep gulch, and are developed, respectively, by what are generally known as the upper workings and the lower workings."

See Figure 6.

"*Upper Workings.*" The geology at the upper workings is obscured by a landslide over the face of the old open cut. A report by the California State Mining Bureau [Bradley and others, 1918, p. 206–208] indicates that the upper ore body was an irregular, flat-lying lens of massive chromite 3 to 10 feet thick. According to S. D. Furber, mining was carried on from three tunnels, one of which was at

least 150 feet long when operations were suspended in 1918. The entrances to these tunnels are now covered by a landslide; a small amount of work done with a bulldozer in 1942 failed to uncover them.

* * * * *

"*Lower Workings.* Development work at the lower workings consists of a large open cut, three small open cuts, an inclined shaft now filled with debris, and a short opening on the east side of the gulch * * *. Mr. Furber states that the shaft is 30 to 40 feet deep, and that a drift was being driven eastward, in ore, from the bottom of the shaft at the time the mine was abandoned.

"The ore occurs in a tabular mass of dunite, which dips steeply to the northeast and is bounded above and below by saxonite. Both rocks are cut by at least four diorite dikes. The eastern contact of the dunite with saxonite is believed to be a shear zone, the dip of which is not apparent; the western contact is obscured by talus. A thin tabular mass of dunite containing a small outcrop of ore is exposed near the top of ridge east of the gulch.

"The main ore body strikes approximately N. 85° E. and dips 60° to 70° N. It is cut by a diorite dike that trends N. 15° E. and dips about 75° SE. Ore has been mined from both sides of the dike, and remnants of ore frozen to the dike indicate that at least part of the ore mined was massive chromite and high-grade disseminated ore. The ore now exposed at the collar of the shaft contains about 30 percent of chromite disseminated in the dunite. The western end of the ore body is bounded by a fault, but disseminated ore exposed near the diorite dikes to the northwest may represent a western extension of the ore body, offset on this fault. The eastern end of the ore body is highly sheared, and the position of a possible eastward extension would depend on the dip and direction of movement in the shear zone, neither of which could be determined.

"A small lens of massive chromite is exposed in the bottom of the gulch, 165 feet east of and 60 feet higher than the collar of the shaft. About 20 short tons of high-grade ore has been mined from this lens and corded on the dump. As neither end of the lens has been delimited, and as the ore still in place has an average thickness of about 2 feet, the lens might possibly yield another 20 tons of ore. Layers of disseminated chromite adjacent to the lens have the same attitude as those in the main ore body.

"Thin layers of chromite are exposed on the steep cliff above the mine workings, but there the chromite does not appear sufficiently concentrated to constitute minable ore.

"If, as can be assumed, the main ore body is 70 feet long and 10 feet thick and extends 25 feet below the outcrop, it may contain 1,700 short tons of ore. Some of this perhaps could be sorted out as shipping ore, but most if not all would probably have to be concentrated. An estimate of inferred ore is not justified because of the limited knowledge of the deposit. There are probably about 1,200 short tons of low-grade concentrating ore in the dump, and the stream wash in the gulch between the upper workings and North Elder Creek may contain 50 to 100 tons of high-grade lump ore. The total reserves indicated in the areas of the upper and lower workings are thus estimated to be almost 4,000 short tons of concentrating ore and 90 to 140 tons of shipping ore.

"Both past production and present indications justify further exploration and development of the lower workings deposit. The shaft and drift should be cleaned out to aid in determining to what depth the main ore body extends, and a possible western extension of the ore body should be looked for by trenching the slope west of the shaft. The operators will probably do this work."

Mill Gulch Area

According to Rynearson (1946, p. 208):

"The Mill Gulch area, in the western part of the NE¼ sec. 16 (T. 25 N., R. 7 W.), is developed by four short adits, now partly filled and caved, and by several trenches and small open cuts * * *. An old mill, erected in 1918 for the purpose of concentrating low-grade ores from this area, has been dismantled and razed.

"The elongate mass of serpentinized dunite in which the ore occurs trends about N. 35° W., and has a moderate dip to the northeast. It is bounded above and below by saxonite, and several dikes of diorite and reefs of rodingite cut both saxonite and dunite. In some places the original contact between the dunite and saxonite is undisturbed; elsewhere both rocks are highly sheared along their con-

tacts. Small masses of saxonite have been isolated in the dunite by the intense shearing, particularly at the northwest end of the area mapped. All the ultramafic rocks are highly serpentinized, especially those which have been sheared, and some of the serpentinized dunite has been further altered to magnesite.

"All the dunite contains a little chromite, but only the dunite containing more than 10 percent of chromite is regarded as ore. The concentration of chromite grains in the ore ranges from less than 1 percent to nearly 100 percent, and the grains are more or less concentrated in parallel layers, which attain a maximum thickness of several feet. The diameters of the chromite grains range from 0.25 to 5 millimeters, and average about 1 millimeter. The richer layers of ore commonly contain the coarser grains.

"The ore zone, of which only the richer part was mapped, crops out over a vertical range of 850 feet and extends for a distance of about 1,750 feet northwestward from the mouth of Mill Gulch. Along the greater part of the zone the ore bodies are only a few inches thick and a few feet long, but the two largest bodies known may contain appreciable reserves. As most of the smaller ore bodies are in a highly sheared matrix, they may not extend more than a few feet below their outcrops, but other similar bodies probably extend to greater depths. These ore bodies are believed to be remnants of one or more ore zones that may have been continuous before the shearing took place.

"The main ore body is exposed on the east side of Mill Gulch, about 500 feet from North Elder Creek. It crops out for 200 feet along the strike, with a maximum thickness of 32 feet and a vertical range of 75 feet. This ore body is relatively undisturbed by shearing except at its southeast end, where it is offset by many small faults and is highly sheared. As the northwest end of the outcrop is obscured by talus and a fault, the ore body may continue in this direction and be more than 200 feet long. On the assumption, however, that its total length is only 200 feet, its average thickness 25 feet, and its extent down the dip 50 feet, the ore body is estimated to contain 25,000 short tons of ore. The ore body may possibly extend as much as 100 feet down the dip, in which case the amount of ore would be about 50,000 short tons; and if it be further assumed that the ore body extends along the strike for 25 feet beyond the fault and under the talus at its northwest end, the estimated total reserves would be 56,000 tons.

"Analysis of 17 samples from the main ore body, made for Wright, Dolbear & Co., show a Cr_2O_3 content ranging from 3.48 to 28.16 percent and averaging 11.6 percent. The chromite in a specimen of ore containing 34.58 percent of Cr_2O_3, when analysed by the Geological Survey, was found to contain 54.86 percent of Cr_2O_3 and to have a Cr:Fe ratio of 3.08:1. This ratio is unusually high, and the results of milling operations during the period 1928–30 prove that the ore could yield concentrates containing more than 45 percent of Cr_2O_3, which would be of metallurgical grade.

"Float and croppings of ore have been found along the strike of the zone for about 800 feet northwestward from the limits of the area mapped. Although no prospecting has been done in this part of the area, it is believed to contain one ore body averaging 5 feet in thickness, continuous for at least 100 feet along the strike and probably extending 20 feet or more down the dip. On the basis of these figures, the ore body is estimated to contain about 1,000 short tons of ore similar in grade to that of the main ore body.

"Another 1,000 tons of ore probably could be mined from other outcrops scattered about the area, and a few tens of tons of milling ore might be recovered from the alluvial material in the gulch. The total reserves of indicated ore in the area are thus believed to be at least 27,000 short tons, and the reserves of indicated and inferred ore combined may be as much as 58,000 short tons [Table 8]. All of the reserves consist of ore that would have to be concentrated. It might be found that a commercial magnesite concentrate also could be recovered from some of the ore that contains an appreciable amount of magnesite.

"Estimates of reserves could be made with more assurance, and would probably be increased if additional exploration were carried out. Core drilling would be difficult, if not impossible, because of the highly sheared condition of most of the rocks, but surface trenching of the scattered outcrops of ore would be very easy. Reopening and extending the lower adit also would yield much information regarding the depth to which the main ore body extends. The northwest end of this ore body should be delimited, which could probably be done by removing the talus and sinking one or more shallow test pits. The possibility of discovering additional ore bodies or proving the continuity of the ore indicated by outcrops in the northwestern

part of the ore zone should be investigated. Removal of the overburden, by a bull-dozer or some other means, should indicate whether further exploration would be necessary or desirable."

Little Red Mountain Group (13)

Small production has come from 11 or more claims of the Little Red Mountain group in secs. 1, 11, and 12, and T. 28 N., R. 10 W., and secs. 7 and 18, T. 28 N., R. 9 W. MDM, on the north slope of Little Red Mountain. Blue Jay, Blue Sky, Jumbo (Red Mountain #2), Live Oak, Macarthur & Lucky Star, Mogul, Panther, Seagrave (Beegum) Snowshoe, Sunshine (Red Mountain #3 & Pine Grove) and several unknown properties—possibly 4th of July, Mary Ann & Southern Pacific lease—were the sources of most of the production during the period 1952–56 (Table 6). However, production listed under a given claim name cannot be assumed to be from the same claim during all periods. The area was not studied carefully.

The topographic map of the Chanchelulla Peak quadrangle shows the highly dissected character of the drainage basin of Beegum Creek and its tributaries. The village of Platina is 46 miles by county road west of Red Bluff. A steep road leads from Platina to Beegum Creek. Access to the claims is by means of jeep trails.

Tedoc Group (22)

Claims on Tedoc Mountain were described by Bradley and others (1918, p. 208–209) as follows:

"A group of 20 mineral claims have recently been located to cover some chromite deposits which occur on the slopes of Tedoc Mountain, at an elevation of over 4,000 feet in Sec. 28, T. 28 N., R. 9 W. They occur in the form of lenses of massive black chromite, which is evidently of high grade. Deposits have been found on several of the claims, but very little development work has been done on them. The largest deposit thus far uncovered is on the Mountain View Claim. It appears to be a blanket, extending north and south down the ridge. A series of trenches has been cut across it, showing a width of from 10 to 20 feet throughout a length of 250 feet. Its thickness or depth has not been determined. The next best showing is on the Dead Pine Claim, which lies to the east of, and adjoining, the Mountain View. Here, two shallow cuts spaced 20 feet apart expose an orebody six feet wide, which appears to be at right angles to the larger body. Small boulders of chromite are found over the slopes on practically all of the claims."

Tomshead Mine (23)

Bradley and others (1918, p. 209) describe the Tomshead mine as follows:

"It is located on the slopes of Toms Head Peak, about midway between the Tedoc Mine on the north, and the Elder Creek mines on the south, 35 miles by road west of Red Bluff. Three to four hundred tons of ore have been mined from a deposit by an open cut, and are lying on the dump. The ore is said to run only 32% chromic oxide, and none has, as yet, been shipped from the property, which is at present idle."

Turner Group (18)

More than a thousand tons of high-grade ore has been produced from the property in secs. 7 and 18, T. 28 N., R. 10 W. During the last 40 years, it has been mined by several operators, has had several owners, and has been known by several different names. When visited during July 1941, I. D. Turner, the owner of several claims in the area, said the property had been operated by Seagrave during World War I and that he had shipped over 500 tons of high-grade ore. A bench about

75 feet above creek level protruded from a landslide that had buried the portal of two tunnels as well as part of a pile of lump ore along the hillside edge of the bench. The tunnels were driven southward 20 feet apart along a layer of massive chromite which was exposed near the middle of the cut. The layer appeared to be horizontal, was 2 feet thick, and was overlain by a zone of completely altered light-green talcose serpentine which ranged from a few to 20 feet in thickness. The chromite has a high chromic oxide content and Cr/Fe ratio.

TRINITY COUNTY

Trinity County comprises an area of approximately 3,100 square miles of rugged mountains; it is principally the drainage basin of the Trinity River. To the south of parallel 40° lies Mendocino County, and Humboldt County lies to the west of meridian 123°30′. Only short straight creeks join the South Fork of Trinity River from the west; however, to the east, the drainage areas of long integrated streams such as Trinity River and Hayfork Creek, with their narrow rugged valleys, comprise over two-thirds of the area of the county. U. S. Highway 299 crosses the county from east to west, from Redding along the Trinity River to Willow Creek, and thence, over the Coast Range to Eureka. Dirt roads feed into this highway but during the rainy season, most of them are impassable.

Geology

An asymmetric geanticline that involves all the pre-middle Cretaceous formations is exposed in the county. Its axis trends about north-northwest, is partly overturned westward, and plunges southward. Hence, going west from the East Fork of Trinity River, one crosses Carboniferous clastic sediments, Upper Triassic volcanic rocks and pyroclastics, and Upper Jurassic shales. There are schists exposed along the axial zone, which in part, may be pre-Carboniferous but certainly in part are younger. Great northwest trending faults are dominant features of the structure. Large quantities of peridotite and diorite intruded these formations in Late Jurassic or Early Cretaceous time. When the region was being arched, the peridotite magma sought out the weak positions in these formations, for example, major stratigraphic breaks, especially between relatively competent volcanic rocks and shales, or between massive sandstones and shale units. Then, dioritic magmas intruded the region and cut up the peridotite masses. These phenomena are well illustrated in the northeastern part of the county where the peridotite and the diorite have an intricate outcrop pattern. Folding and uplift followed by profound erosion exposed the peridotite.

Peridotite forms the country rock over about 300 square miles of northeast Trinity County; most of the chromite production has come from that area. To the southwest of this, and extending north-northwest across the county, are a series of narrow, dike-like masses of peridotite and serpentine. No production has been reported from them. A parallel belt to the southwest, consisting of more than 30 peridotite bodies that range in size from a square mile or less to as much as 15 square miles in areal extent, crops out from the southern county boundary northwest to Trinity River. A few small bodies crop out in the southwestern

Table 9. Chromite production from Trinity County, California, as of 1957 (in long tons).

Property	1916	1918	1920	1928	1929	1940	1941	1942	1943	1952	1953	1954	1955	1956	1957	Total
Bald Mountain									48							48
Big Hunk (Little Nellie)											11	11				22
Billie Mac												5				5
Bitten Bender												5				5
Black Bear											9					9
Bragdon								100								100
Cedar														5		5
Charlene Sue														6		6
Chrome												6				6
Chromite No. 1												16				16
Costa Claim													33		54	87
Cotton										7						7
Crow Creek group												304				304
Crow's Nest					89											89
Dorothy									9							9
Dry Ridge											88					88
Dubakella		52														52
Empire						100		21								121
Foster and Cuff		11														11
Happy Go Lucky (Oak Ridge)												35		10		45
Hayden								20								20
Hillster													5			5
I Wonder												12				12
Little Goat											11					11
Lost Dog															8	8
Mule Creek								33								33
Mumbo Creek (Russell group)		160									85		6			251
Old Bill														15		15
Old Bones		80														80
Old Violet									5							5
Phillpot, C. H.	268															268
Railroad leases (Section 11)		1,058		312				312	11							1,693
Redskin												19		15		34
Schules		4	3													7
September Morn								64								64
Shamrock												34		16		50
Starr-Bee												19	12	15		46
Starsteel													5			5
Sunnyslope								52	6							58
Tangle Blue Divide								97								97
Three B's										31						31
Vance group							480									480
Wagner, B.									11							11
Yellow Jacket							12									12
Yellow Pine								206								206
Unknown		22									9					31
Total	268	1,387	3	312	89	100	625	772	90	38	213	466	61	82	62	4,568

part of the county. Chromite deposits have been located in many of the bodies in this belt.

History and Production

The first reported shipment of chromite in Trinity County was in 1916, and the greatest production was in 1918. For 1918, Diller (1922, p. 30) reported that "the total quantity of ore shipped from the county during the year was 1,556 short tons, and at the end of the year, 2,729 tons of mined ore remained unshipped, almost wholly at the mines. This large proportion of unshipped ore is due chiefly to the long haul and the fact that the ore bodies were not reached until late in the year." The largest total amount produced from a single property was 1,693 long tons from the Railroad Lease, which includes several deposits in sec. 11, T. 38 N., R. 6 W. MDM. Chromite is known to have been shipped from 46 deposits listed in Table 10. The total recorded production (Table 9) through 1957 is 4,568 long tons.

Mumbo Basin Area

The Mumbo Basin area is at the head of Mumbo Creek, a tributary of the East Fork of Trinity River. It includes the southern half of T. 39 N., and the northern tier of sections of T. 38 N., R. 6 W. MDM (Plate 19). Most of this upland area is above an altitude of 5,000 feet and the highest peaks rise to 7,200 feet. Access to this region was provided during World War II by a logging road from the upper reaches of the south fork of the Sacramento River over the divide into Mumbo Basin. This dirt road has good grades and can be traveled easily during dry weather. It is closed at the summit, altitude 6,660 feet, during late autumn, winter, and early spring. The Mumbo Basin is 18 miles from U.S. Highway 99. The shipping point is at Mount Shasta.

According to Averill (1931) (Plate 19), a large body of gabbro intrudes the peridotite in this area. As seen in the outcrop, the peridotite does not appear to be much serpentinized except near the gabbro contact.

Chromite was known in the area during World War I but was too remote to warrant mining. During World War II, Mr. P. C. Munko reported (oral communication, 1944) that he shipped a carload of ore from this area to the Metals Reserve stockpile in Sacramento during 1944, and a shipment of 11 long tons of ore was purchased from this area by the Metals Reserve at Yreka. The 11 tons assayed 37.11 percent Cr_2O_3, 12.93 percent Fe, and had a Cr/Fe ratio of 1.93. The area was briefly visited without a guide in late 1944, but the chromite occurrences were not found.

Mumbo Creek (33) and Picayune Lake (29) Groups

Two groups of claims located during World War I were briefly described by Bradley and others (1918, p. 211) as follows:

"Mumbo Creek Group, (formerly Russell Group), Mrs. Luella Beauchamp, owner, #591 Turk St., San Francisco. This group of four claims is in Sec. 4 (?) or 11, T. 38 N., R. 6 W., something over a mile north of the Crow Creek group, and about 19 miles from Castella. They will utilize the same road, now under construction. The ore so far exposed is high grade, but only a small amount of development work has been done, as yet.

Table 10. Alphabetical list of chromite mines and prospects in Trinity County, California, giving old names, locations, owners, and operators.

Name of mine or prospect	Map no.	Location (MDM)			Name of owner (O) or shipper (S)	Source of data	Class[1] by production
		Sec.	T.	R.			
Bold Mountain						U. S. B. M.	C
Big Hunk (Little Nellie)						U. S. B. M.	C
Billie Mac						U. S. B. M.	C
Bitten Bender						U. S. B. M.	C
Black Bear	45x	24	4N	7E	Lowell Norgaar (S)	U. S. B. M.	C
Black Jack	73o	SW 28	30N	12W	William Prath (O, S)	Bradley and others, 1918, p. 211	C
Blondy (Surprise)	71x	23	30N	12W		Diller, J. S., 1918, unp.	D
Boyer group	80	NE 9	29N	11W	Dave Boyer (O)	Rynearson, G. A., 1943, unp.	C
July 1 and July 2							--
September Morn							--
Bragdon	44o	19	35N	8W	Eddie Bragdoo (O); Charles Hath (S)		C
Brown Bear	83x	1	29N	12W		Diller, J. S., 1918, unp.	D
Charlene Sue	34x	14	38N	6W	C. L. Kalbaugh (S)	U. S. B. M.	C
Chrome	42x	3	36N	6W	L. L. Hodges	California Division of Mines and Geology files	C
Chromite No. 1						U. S. B. M.	C
No. 1	61x	10	2N	7E	L. Norgaar	U. S. B. M.	C
Collins group	78					Rynearson, G. A., 1943, unp.	C
Cedar Nos. 1, 2, 3 and 4		SW 11	29N	11W	M. W. Collins (O)	U. S. B. M.	C
Chrome Center		3	29N	11W	do		--
Dry Cedar		W/2 2	29N	11W	do		--
Five O'Clock		3	29N	11W	E. A. Collins (O)		--
Green Chrome		3	29N	11W	M. W. Collios (O)		--
Iridium		3	29N	11W	do		--
Junction No. 1		NW 14	29N	11W	E. A. Collins (O)		--
Junction No. 2		SW 11	29N	11W	do		--
Junction Extension		11	29N	11W	M. W. Collins (O)		--
Low Gap		NW 11	29N	11W	E. A. Collins (O)		--
Pride of Trinity		3	29N	11W	do		--
Rattlesnake		3	29N	11W	do		--
September		3	29N	11W	do		--
Summit Nos. 1 and 2		3	29N	11W	M. W. Collins (O)		--
Sunnyslope (Shamrock)		SW 11	29N	11W	E. A. Collins (O)	U. S. B. M.	C
Sunnyslope No. 2		11	29N	11W	M. W. Collins (O); A. F. Kohle and I. F. Sauer (S)		--

Compass	69o	SE 21	30N	12W		Bradley and others, 1918, p. 211	C
Compton	81x	22	29N	11W		Diller, J. S., 1918, unp.	C
Copper King	40o	2	37N	6W	G. Bland (O)	Diller, J. S., 1918, unp.	C
Costa claim (Tiger Lily)	36o	SW 14	38N	6W	George Costa (O, S)	Wells, F. G., 1943, unp.	B
Cotton						U. S. B. M.	C
Crow's Nest						U. S. B. M.	C
Dorothy						U. S. B. M.	C
Dry Ridge	46x	24	4N	7E	L. Norgaar (S)	U. S. B. M.	C
Duba Kella							C
Eltapam	47x	29	4N	7E		Diller, J. S., 1918, unp.	C
Empire	75o	SW 31	30N	12W	A. Rais and E. Phair (O); C. O. Benson (S)	Ryncarson, G. A., 1943, unp. Averill, 1941, p. 18	C
Eureka	66x	NE 18	30N	12W	Frank Cummins	Bradley and others, 1918, p. 211; Diller, J. S., 1918, unp.	C
Evalina (Dry Camp)	84o	4	28N	11W	D. Turner (O)	Rynearson, G. A., 1943, unp.	C
Federal	76x	SE 33	30N	12W	F. Brewer et al.	California Division of Mines and Geology files	C
Foster and Cuff	72x	25	30N	12W		Diller, J. S., 1918, unp.	C
Gray Fox (Roosevelt)	79o	Cen. 6	29N	11W		do	C
Green Stripe Chrome mine	31x	8	38N	6W	G. L. Costa	Averill, 1941, p. 18	C
Grubstake	85x	20	26N	12W	Alton Iliff and I. Anderson (O)	Rynearson, G. A., 1943, unp.	C
Happy Go Lucky (Oak Ridge)	62x	10	2N	7E	E. A. Lough	California Division of Mines and Geology files	C
Hayden						U. S. B. M.	C
Hillister						U. S. B. M.	C
Hoelling claims	77x	common cor. 20, 21, 28, 29	1N	8E	H. W. Hoelling (O)	Averill, 1941, p. 18	C
I Wonder	82x	26	29N	11W	Black Rock Mining Co.	U. S. B. M.	C
Integral (Cinnabar) mine	37o	22	38N	6W	Integral Quicksilver Mining Co., P. C. Munko	Averill, 1941, p. 18, Bradley and others, 1918, p. 210	C
Jeffery Pine	49o	NE 25	4N	6E	Mrs. W. P. Stanton (O)	Ryncarson, G. A., 1943, unp.	C
Little Ann Chrome and Mumsie A Chrome Mines	54x	30	31N	12W	Mr. and Mrs. D. E. Frye (O)	Averill, 1941, p. 18	C
Little Goat						U. S. B. M.	C
Lost Dog mine	57x	34	31N	12W	Alvin Cottrell (O)	Averill, 1941, p. 19	C
Lost Horse	65x	13	30N	12W	W. C. Duncan (O)	Diller, J. S., 1918, unp.	D
Maringer mine	55x	34	31N	12W	Frank Maringer (O)	Averill, 1941, p. 19	C
McKay and Abbott	58x	6	2N	8E		Diller, J. S. 1918, unp.	C
Mule Creek	43o	NE 19	35N	8W	W. C. Whitt (S)	Yreka, M. R., 1945, unp.	C
Mumbo Creek group (Russell group)	33o	11	38N	6W	Mrs. Luella Beauchamp (O)	Bradley and others, 1918, p. 211	B
Old Bill						U. S. B. M.	C
Old Bones	64x	34	30N	11W	L. F. Shock (O)	Diller, J. S., 1918, unp.	D
Old Violet							C
Pallestreau	50x	23	3N	7E		do	D
Pewee claim	70o	21, 22	30N	12W	Roy Shiell and William Prath	Bradley and others, 1918, p. 212	D
Phillpot	53x	2	31N	2W	C. H. Phillpot (O)	do , p. 211	B
Picayune Lake group	29x	23, 26, 27	39N	6W	H. C. Beauchamp (O)	do	C

Table 10. Alphabetical list of chromite mines and prospects in Trinity County, California, giving old names, locations, owners, and operators (concluded).

Name of mine or prospect	Map no.	Location (MDM)			Name of owner (O) or shipper (S)	Source of data	Class[1] by production
		Sec.	T.	R.			
Pink Crystal (Costa lease)	39x	25, 26	38N	6W	Elmo Pickering and Bud Wagner (O)	Averill, 1941, p. 19	--
Railroad lease (Section 11 mine)	32o	SW 11	38N	6W	Southern Pacific Railroad (O)	Wells, F. G., 1943, unp.	A
Red Mountain	86x	20, 21	26N	12W	P. A. Pesule (O)	Averill, 1941, p. 19	C
Redskin							C
Sangra La (Vance group)	60o	9	2N	7E	Vance and Barnes (O)	Rynearson, G. A., 1943, unp.	C
Schreckengost group	52o	14	31N	10W	Ed Schreckengost (O)	do	C
Schules	51x	27	3N	7E		Diller, J. S., 1918, unp.	D
Section 14 (Crow Creek group), McConnell-Kirby, Chapman-Kirby	35o	14	38N	6W	P. S. Munko (O, S)	Bradley and others, 1918, p. 210; Wells, F. G., 1942, unp.	B
Stanton Chrome, Stanton Chrome Extension	48o	24	4N	6E	Mrs. W. P. Stanton (O)	Rynearson, G. A., 1943, unp.	C
Starr-Bee						U. S. B. M.	C
Starsteel						U. S. B. M.	C
Summit	38x	24	38N	6W	Elmo Pickering and Bud Wagner	Averill, 1941, p. 19	C
Tangle Blue Divide	30o	13	39N	8W		Yreka, M. R., 1942, unp.	C
Three B's			33N	12W	Brewer and Cherry (S)	U. S. B. M.	C
Tule Creek	56x	34	31N	12W	Rollin and Maringer (O)	Averill, 1941, p. 20	C
Vance group (Sangra La)	59x	NW 9	2N	7E	Vance and Barnes (O)	Rynearson, G. A., 1943, unp.	B
Wagner, B.							C
Western Chrome No. 1	74o	W/2 30	30N	12W	C. O. Benson (O)	Rynearson, G. A., 1943, unp.	C
Western Chrome No. 3	68o	SW 19	30N	12W	do	do	C
Western Chrome No. 4	67o	NE 19	30N	12W	do	do	C
Wildcat Chrome	41x	33	37N	6W	A. D. Grafton (O)	Averill, 1941, p. 20	C
Yellow Jacket						California Division of Mines, 1941	C
Yellow Pine	63o	SE 10	2N	7E	J. E. Winters	Anderson, M. R., 1942, unp.; Yreka, M. R., 1942, unp.; and Rynearson, G. A., 1943, unp.	B

[1] A—1,000 long tons or more
B—150–1,000 long tons
C—Less than 150 long tons
D—No ore shipped

"Picayune Lake Group, H. C. Beauchamp, owner, care Columbia Hotel, San Francisco. This group of 14 claims is in Secs. 23, 26, and 27, T. 39 N., R. 6 W., several miles northeast of Crow Creek Group, and 16 miles southwest from Sisson. Of the latter, 10 miles is by trail. This group was located in July 1917, covering several outcrops of high-grade chromite."

A production of 160 long tons of ore was reported from the Mumbo Creek group in 1918.

Crow Creek Area

The Crow Creek area lies at the head of Crow Creek, a short tributary of the East Fork of Trinity River in T. 38 N., R. 6 W. MDM, just west of the crest of the Sacramento Mountains and about midway between the Sacramento and Trinity Rivers (Plate 19). A graded dirt road passes through the area, connecting Castella on the Sacramento River with Trinity Center on the Trinity River. The part of the road above 5,000 feet in altitude is closed by snow from the first heavy snowfall in October or November until May or June. It is possible to reach the area for a few weeks longer from the Trinity River side. The area is sometimes called the Altoona district, as the Altoona and Integral quicksilver mines are in the western part.

Peridotite underlies most of the area but the main contact of a large stock of gabbro lies just to the west and apophyses of the gabbro cut the peridotite. The peridotite is serpentinized wherever exposed, and much of it is sufficiently sheared to be called slickentite. Important faulting is present in the Altoona and Integral mines, and evidence of deformation is common in all of the chromite diggings. Concentrations of chromite of the disseminated type are widespread. In places the chromite is concentrated enough to be cobbed to a product containing 35 to 40 percent Cr_2O_3, but no massive ore is present.

Section 11 is owned by the Southern Pacific Company, and was leased to various operators. Much of section 15 is patented ground of the Integral mine, and much of section 22 is patented ground of the Altoona mine. Other properties in this vicinity were mined or explored during the period June 1942 to October 1944, and are described in decreasing order of importance, as judged in 1944. They are the Costa claim, Railroad Lease (Section 11 mine), claims in Section 14, and the Integral mine (Cinnabar Point claim).

Costa Claim (Tiger Lily) (36)*

George Costa holds one claim called the Tiger Lily in the SW¼ sec. 14, T. 38 N., R. 6 W. MDM. The property lies along the west side of Crow Creek, and is 0.4 mile below the Forest Service road.

The ore body was exposed by an open cut in the hillside about 200 feet above the creek at an altitude of 4,200 feet. The cut trends N. 65° E. and when examined in September 1943 was 70 feet long. The peridotite in which the chromite occurs is highly faulted, altered, and comminuted to slickentite. The chromite occurs as disseminated grains that form about 60 percent of the ore. The concentrations of chromite are terminated by faults. Concentrations of chromite were seen in the Forest Service road cut above the workings and at other places on the claim. Kammererite and uvarovite were not seen in the ore, but nickel bloom is conspicuous, and small amounts of cinnabar were present.

* Numbers following mine names refer to map, Plate 19.

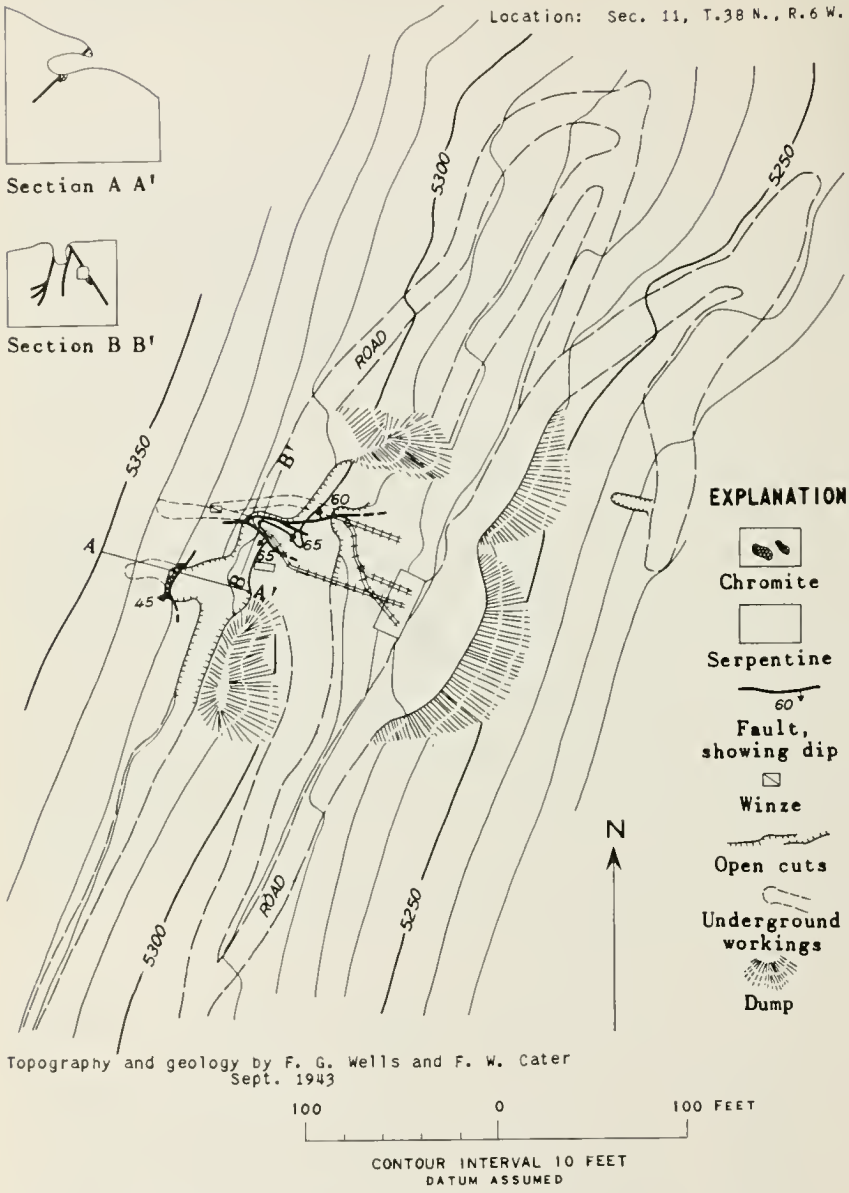


Figure 7. Geologic map and sections of the Railroad Lease Section 11 mine, Trinity County, California.

According to P. C. Munko (personal communication, 1945), 500 short tons of milling ore was shipped in 1942 and in 1943, another 100 short tons was shipped to the mill at Castella.

Railroad Lease (Section 11 Mine) (32)

This property is owned by the Southern Pacific Company. During 1942, and for some time previously, it was leased to A. H. Wild. From 1943 to 1945, it was leased to P. C. Munko and his associates, who were known as the Dunsmuir Chrome Co.

The workings are in SW¼ sec. 11, T. 38 N., R. 6 W., MDM, on the west slope of the west fork of Crow Creek at an altitude of 5,300 feet. They are 1.2 miles north of the Forest Service road. In September 1943, the workings consisted of three adits and a trench, exposing ore over a vertical distance of 100 feet. The distribution of the workings is shown in Figure 7.

Serpentine was the only rock seen in the area. Several faults cut the serpentine. One strikes N. 85° E. and dips about 60° north; a complementary set is similar in strike but dips 65° south. These tend to horsetail out, probably swinging into the third fault which strikes about N. 25° E. and dips westerly about 45°. Where north-trending faults are offset by the east-trending north-dipping faults the north blocks are displaced to the west.

Most of the deposit is rich disseminated ore rather than massive chromite. Pod-like masses of high-grade ore are found, but they are faulted segments of rich chromite concentrations that were broken loose from bodies of disseminated ore, and that formerly graded outward to barren rock. Chromite has been uncovered at intervals over a vertical range of 100 feet. The ore shoot was about 5 feet wide and 30 feet long. The body being mined in September 1943 pitched to the east. This body pinched and swelled from a thin edge to a maximum thickness of 6 or 7 feet. Kammererite is commonly encrusted on joint surfaces.

The total recorded production from the Railroad Lease (Section 11 mine) through 1944 was 1,693 long tons of chromite ore, of which 1,058 long tons were mined during World War I. Munko reports (oral communication, 1945), that during 1943 he shipped 20 long tons of ore to the Metals Reserve stockpile at Yreka, and 60 long tons of shipping ore to the Montrose Mining and Milling Co. Those shipments are not distinguishable in the records so, for the sake of consistency, they are not added to known production (Table 9) although they might rightly belong there.

Section 14 Mine (35) (Crow Creek Group, McConnell-Kirby, Chapman-Kirby)

Crow Creek flows south through the center of sec. 14, T. 38 N., R. 6 W., MDM, and the Forest Service road crosses the creek almost on the northern boundary of the section. Chromite was mined from this section during World War I. Bradley and others (1918, p. 210) described the operations as follows:

"* * * Development work consists of a number of open cuts and one adit crosscut. Several lenses of chromite have also been revealed by clearing off the surface soil. In the cross-cut, a face of ore has been opened up 10′ wide and 18′ high. Some of the chromite is massive and high grade. The green chrome-garnet, uvarovite, is associated with the fracture planes in the chromite. It is estimated that

there are at least 2000 tons of 40%–42% ore available. This includes approximately 800 tons already broken and ready to ship as soon as the road is completed, the coming spring. One carload (42 tons) analyzing 44% Cr_2O_3 and 7% SiO_2 was packed five miles to the road, and delivered by truck to the railroad at Castella in December * * *"

P. C. Munko holds two claims in the northeastern quarter of the section above the Forest Service road. Two trenches were dug on chromite about 80 feet above Crow Creek at an altitude of 5,100 feet. The hillside is steep. Sinuous ribbons of chromite, one-half inch or less in thickness, traverse the serpentine in an irregular manner. In general, they trend N. 20° E., but the dips vary widely.

Munko reports (oral communication, 1945) that he shipped 3 long tons of ore carrying 50 percent chromic oxide. The destination of this shipment and the ore reported by Bradley and others (1918) cannot be traced.

Integral Mine (Cinnabar) (37)

The Integral Quicksilver Mining Co. has leased several of its patented claims in sec. 22, T. 38 N., R. 6 W., MDM, to P. C. Munko and his associates for the purpose of mining chromite. The property explored lies both above and below the Forest Service road. Much of the surface had been turned over by a bulldozer when visited in September 1943. Little could be learned from the torn-up surface, but the churned-up rock is slickentite. According to Munko (oral communication, 1943) the ore occurs as pods of massive chromite that range in size from a few pounds to 4 tons. He also reported a production of 11 tons of ore averaging 39 percent Cr_2O_3.

Trinity Alps Area

The Trinity Alps area consists of the drainage basin of the Trinity River above the mouth of the Stuart Fork near Minersville. It is a region of high relief, the altitudes ranging from 2,002 feet above sea level on the Trinity River to 8,915 feet above sea level on the crest of Sawtooth Mountain. The snowfall is heavy and during much of the year working conditions are severe. A dirt road follows the valley of the Trinity River, and dirt roads lead off of it part way up the valleys of Stuart Fork, Swift Creek, Coffee Creek, and Tangle Blue Creek (Plate 19). Trinity Center * is the principal settlement. Although this part of the valley of the Trinity River may be entered from the north or south, the usual route is by way of a road over the Trinity Mountains from Delta to Trinity Center, a distance of about 24 miles. La Moine, a shipping point on the Southern Pacific Railroad, is 2½ miles north of Delta.

More than half of the Trinity Alps area, or more than 300 square miles, is underlain by peridotite. It has been intricately intruded by dioritic rocks which give it an irregular map pattern. A few hundred tons of chromite ore were shipped from this area, and four deposits are recorded. Whether this lack of recorded deposits truly indicates an absence of commercial concentrations of chromite in this large peridotite area, or indicates a failure of chromite prospectors to locate

* Ed. note: Since Trinity Dam was completed at Lewiston in 1963, a paved highway connects Trinity Center with Highway 299.

such deposits, is not known. Miners and prospectors who swarmed over these mountains since the 1850's probably would have noticed any conspicuous outcrops of chromite. Although the region is rugged and poorly served by roads, important chromite deposits were developed in other equally or more remote and undeveloped parts of the Klamath Mountains when chromite was in demand during World War I.

During World War II chromite was mined and shipped to the Metals Reserve stockpiles from three deposits, the Tangle Blue Divide (30) *, the Mule Creek (43) *, and the Bragdon (44) *. The amounts and tenor of the ore are listed below:

Assays by Abbot A. Hanks.

Name	*Long tons*	*Cr_2O_3*	*Fe*	*Cr/Fe*
Tangle Blue Divide	97	45	--	2.95
Mule Creek	32.64	44.40	10.88	2.81
Bragdon	100	46	--	--

Hayfork Mountain Area

A body of peridotite about a mile long crops out from the crest of Hayfork Mountain down into Maupin Gulch. Maupin Creek is a short westward tributary of Browns Creek, in secs. 23 and 24, T. 31 N., R. 10 W., MDM. Little is known of the character of this peridotite body except that it is surrounded by stratified rocks that probably are Paleozoic in age.

The area is served by the Browns Creek Forest Service road which leaves U.S. Highway 299 about 48 miles west of Redding.

Schreckengost Group (52)

Ed Schreckengost and son located the Schreckengost, the Schreckengost Nos. 1, 2, 3, 4, and 5, and claims at the head of Johnson Gulch in sec. 14, T. 31 N., R. 10 W., MDM. The deposits are about 2 miles west of the Forest Service road. The owners stated (oral communication, 1943) that only location work had been done, and that 17 long tons of ore had been mined on one claim, and 5 or 6 tons on another. There is no record of ore shipped from these claims.

Eltapom and Hyampom Creeks Area

The Eltapom and Hyampom Creeks area is in the drainage basin of the South Fork of Trinity River near the western boundary of Trinity County. The area is remote from the main routes of travel, and until the last few years the roads into it were closed during much of the winter. It is 22 miles from Hyampom to the paved road at Douglas City and thence 54 miles to Redding.

Detailed geologic work has not been done in this part of Trinity County, but it is known that the rocks generally trend north-northwest and that elongate patches of peridotite or serpentine occur with the same trend in the older rocks.

Stanton Chrome and Stanton Chrome Extension (48)

These claims are owned by Mrs. W. P. Stanton and in 1943 were leased to R. H. Matson, W. N. Trimball, and Bert Ward. They are on

* Numbers following mine names refer to map, Plate 19.

the north side of Eltapom Creek in sec. 24, T. 4 N., R. 6 E., HM, and were accessible by about 6 miles of trail from the Forest Service Road between Big Bar and Hyampom.

The main ore body probably was a large pod of nearly massive chromite which was eroded from serpentine, broken up, and scattered for two or three hundred yards down slope. The pod probably was removed completely, as several cuts failed to find ore in place at the highest points at which chromite float was found. A smaller pod weathered out of the serpentine about 400 feet S. 40° E. from the main pod. As the uppermost float from the main pod follows the contour in this same direction, it seems advisable to prospect the intervening area with the hope of uncovering more pods. At least 50 long tons of float ore (1943) were in sight on the hillside in 1943, and it is possible that an additional 100 long tons is buried in the soil.

Jeffery Pine Claim (49)

The Jeffery Pine claim, in NE¼ sec. 25, T. 4 N., R. 6 E., H.M., is about half a mile south of the Stanton claims and is reached by the same trail from the Big Bar-Hyampom road. The visible ore consists of float, although some may be in place in the location pit. About 50 tons of float ore were in sight (1943), the largest block containing at least 12 tons of massive chromite. Additional prospecting probably will uncover more float ore, and may reveal ore in place.

Pallestreau (50) and Schules (51) Claims

During World War I, Mr. Pallestreau located many chromite occurrences in the Hyampom area. Among them are the Pallestreau claim in sec. 23, T. 3 N., R. 7 E., HM and the Schules claim in sec. 27. From the description given by Mr. Pallestreau, little work was done on these claims and the chromite found was mostly float.

Indian Valley-Forest Glen Area

Many elongate bodies of peridotite crop out in the area between Hayfork Creek and the South Fork of Trinity River southeast of Hyampom. Those lying to the northwest of Dubakella Mountain are grouped for convenience into the Indian Valley area and the Forest Glen area. Forest Glen guard station is connected by 22 miles of gravel road to the main road along the Hayfork Creek about a mile west of the settlement of Hayfork. The settlement is connected by paved road to Douglas City 20 miles to the east and thence 45 miles to Redding, an overall distance to the railroad of 87 miles. Several dirt roads and truck trails cover both the Forest Glen and Indian Valley areas.

The region is an upland, mostly above 4,000 feet in altitude, across which the two forks of the Trinity River have trenched steep canyons about 2,000 feet deep. The geology of the region has not been mapped in detail. The chromite is of good grade.

Vance Group (59) Including Sangra La (60)

Vance and Barnes of Hayfork located or acquired 11 claims in Indian Valley and vicinity. Only one claim, the Sangra La in NW¼ sec. 9, T. 2 N., R. 7 E., HM was examined by the writer. Several trenches were dug on the claim during World War I, but only one exposes ore

in place. Reserves of about 10 tons of chromite ore are indicated. This claim was described by the owners as having the best showing of any claim in the group.

Yellow Pine Mine (63)

Ore has been shipped from only one property in the Indian Valley area, the Yellow Pine mine. It is in SE¼ sec. 10, T. 2 N., R. 7 E., HM, on a dirt road about 14 miles from the paved road at the village of Douglas City on the Trinity River. The deposit is owned by C. M. Shock and is leased to T. G. Knowles. Development consists of a bulldozer cut 150 feet long and 100 feet wide from which most of the ore was removed. The ore occurred as a kidney-shaped body in intensely sheared serpentine. In September 1943, a small amount of ore on the western wall of the cut indicated that the ore body trended N. 30° W. with a dip of about 20° S. In 1942, this deposit yielded 206 long tons of ore that was shipped to the Metals Reserve stockpile at Anderson. The ore assayed 49.74 percent Cr_2O_3, 12.76 percent Fe, and 2.76 Cr/Fe ratio. Unless the ore still in place widens into another pod, the reserve in this ore body is not more than 3 tons. A small amount of prospecting with a bulldozer west and north of the cut could easily determine whether another kidney of ore is present.

Pewee Claim (70)

The Pewee claim is near the south corner common to sees. 21 and 22, T. 30 N., R. 12 W., MDM, less than half a mile from State Highway 36 and 8 miles from Peanut. Roy Shiell and Wm. Pratti, of Peanut, were the original locators. The outcrop is a lens of chromite ore of good grade, 4 feet wide by 20 feet long; it has been trenched to a depth of 1½ feet.

The prospect is at an altitude of 4,500 feet and is so situated that ore could be hauled to State Highway 36 with little road-building expense. The quality and quantity of ore in sight justified mining. There was, however, a dispute as to the ownership.

Deposits Described by Diller

J. S. Diller briefly visited the Forest Glen area in the summer of 1918 and reported (files of the U.S. Geological Survey) nine chromite properties. He believed that the Lost Horse (65),* Blondy, Surprise (71),* Old Bones (64),* and Brown Bear (83) * probably occurred in one zone that extends south from the Lost Horse. From his notes it would appear that the chromite in this zone generally occurs as irregular small lumps, stringers, and disseminated ore scattered through the peridotite. He estimated that at most of the deposits the chromite was not sufficiently concentrated to be shipping ore, although some massive chromite was seen. Apparently none of these deposits was actively developed during World War II. Further work would be required to determine whether the deposits are large enough to justify a milling operation.

Deposits Described by Averill

Averill (1941, p. 16–20) described five chromite deposits in the Indian Valley area. They are the Little Ann Chrome mine and Mumsie

* Numbers following mine names refer to map, Plate 19.

A Chrome mines (54),* Tule Creek claim (56),* Maringer mine (55),* Lost Dog Mine (57),* and Empire claim (75).* The location and ownership of these claims is given in Table 10.

Upper Mad River Area

A mass of peridotite forms Red Mountain in T. 26 N., R. 12 W., MDM, between the headwaters of the Mad River and the North Fork of Eel River in southwestern Trinity County. Red Mountain has been prospected, and one deposit of chromite mined. A dirt road follows the valley of the Mad River from the post office of the same name on the Forest Glen road up to Three Forks, a distance of 25 miles. At a distance of 20 miles, a side road leaves the Mad River road and follows Armstrong Creek to the ridge top and south along the top about 4 miles. Thence, it is 4 miles by trail to Red Mountain (Plate 19).

Grubstake Claim (85)

The Grubstake claim is on the summit of Red Mountain in NE¼ sec. 20, T. 26 N., R. 12 W, MDM. The property was developed during World War I by a 27-foot tunnel which is now caved; 15 to 20 tons of ore were mined but not shipped. Narrow stringers of ore are reported by Alton Iliff and L. Anderson (1943), to be in the face of the tunnel, and a recent open cut above the tunnel shows some ore. Mr. McKnight, the owner of the Blue Jay manganese mine and former locator of the claim, estimates the total reserves of the deposit to be 30 to 40 tons. The property was relocated by Alton Iliff and L. Anderson who, in 1943, planned to pack the ore over 2 miles of trail to the Blue Jay mine road. The property was not visited by the writers.

Upper Hayfork Creek Area

Many chromite claims have been located on the peridotite masses in T. 29 N., R. 11 W., MDM, south of State Highway 36, which crosses Hayfork Creek at Wildwood. The geology of the area has not been studied in detail, so the distribution of the peridotite is only imperfectly known. However, the peridotite masses are part of a belt that extends from Tedoc Mountain in western Tehama County northwest to Dubakella Mountain and includes the Little Red Mountain area previously described.

Collins Group (78)

E. A. Collins and M. W. Collins located 23 claims in T. 29 N., R. 11 W., MDM, in the upper Hayfork area, as listed below. The deposits are served by the Forest Service road along the upper part of Hayfork Creek.

E. A. Collins	*M. W. Collins*
Junction Nos. 1 and 2	Junction Extension
Sunnyslope	Cedar Nos. 1, 2, 3, and 4
Low Gap	Low Gap Extension
Meadowslope	Green Chrome
Five O'Clock	Chrome Center
September	Iridium Chrome
Rattlesnake	Summit Nos. 1, 2, and 3
Pride of Trinity	Sunnyslope No. 2
	Dry Cedar

* Numbers following mine names refer to map, Plate 19.

In 1943, a Mr. Allwood of Redding held a lease on the Junction and Sunnyslope claims. Several open cuts were made on the Sunnyslope and Low Gap claims, and ore was shipped from the Sunnyslope claims. Only a small amount of location and prospecting work has been done on other claims of the group.

The ore occurs as zones of stringers and small pods of chromite associated with thin masses of dunite in saxonite. The central part of the peridotite mass, where the Junction, Sunnyslope, and Cedar claims are located, consists of fresh saxonite and dunite, whereas the surrounding parts of the mass are partly altered to serpentine, and the borders are highly sheared and serpentinized. Probably not more than 600 to 700 long tons of ore will be produced from the area.

The claims of the group that are not described below show little promise of containing significant quantities of ore, although additional prospecting may develop a few tons.

Junction Nos. 1 and 2 Claims

The Junction No. 1 claim is in NW¼ sec. 14, T. 29 N., R. 11 W., MDM. A few tons of coarse-grained disseminated ore are visible in the bottom of a small cut near the bottom of Hayfork Creek. Some smaragdite(?), a thin foliated amphibole, is in the ore.

At the Junction No. 2 claim in SW¼ sec. 11, T. 29 N., R. 11 W., MDM, a small cut exposes a 1-foot zone of high-grade disseminated ore. The zone strikes north and dips 75° E. Ore is said to crop out for 400 feet along this zone, but nearby outcrops indicate that the rest of the zone is too thin to be mined even by surface work.

Sunnyslope Claim

The Sunnyslope claim is in SW¼ sec. 11, T. 29 N., R. 11 W., MDM. The ore occurs in a sheet of dunite about 5 feet thick. Ore was exposed for about 75 feet along a vertical zone that strikes N. 5°–10° W. The ore is a maximum of 3 feet in thickness and probably averages about 1 foot. The ore body was developed to a depth of 15 to 20 feet, and 82 long tons were shipped. Reserves of about 200 long tons of ore are indicated.

In 1945, 19.36 long tons of chromite ore were recorded as shipped from a Sunnyslope mine to the Metals Reserve stockpile at Anderson by A. F. Kohle and J. F. Sauer. The ore assayed 39.04 percent Cr_2O_3, 9.37 percent Fe, and had a Cr Fe ratio of 2.85. As no location is given for the site of the mine, it is not certain that it came from this property. During the same year, A. R. Bickford shipped 13.25 long tons to the Anderson stockpile from the Collins property near Wildwood. It assayed 29.32 percent Cr_2O_3, 8.07 percent Fe, and had a Cr/Fe ratio of 2.30. This is too low grade to be classed as ore. In 1942, J. Shafter shipped 53 long tons of ore from the Collins group. It assayed 44.33 percent Cr_2O_3, 11.28 percent Fe, and had a Cr Fe ratio of 2.69. This shipment probably came from the Sunnyslope claim.

Cedar No. 4 Claim

The Cedar No. 4 claim is in SW¼ sec. 11, T. 29 N., R. 11 W., MDM. A cut about 25 feet long on the side of a cliff exposes a few stringers of ore in a vertical zone which strikes N. 9° W. The largest stringer is

about 1 foot thick and 3 feet long. Only a few tons of shipping ore are in sight.

Low Gap Claim

At the Low Gap claim, in NW¼ sec. 11, T. 29 N., R. 11 W., MDM. coarse-grained disseminated chromite occurs in a vertical zone, which strikes N. 5° W., in highly sheared dunite. The ore zone pinches and swells, and its maximum thickness is 4 feet. There is some indication that the zone may widen with depth. Three open cuts expose the zone for a strike-length of about 90 feet. About 15 to 20 long tons of shipping ore are stacked on the dumps. The estimated reserves are 200 long tons. Additional development may increase the reserves.

Dry Cedar Claim

The Dry Cedar claim, near the common quarter corner of sees. 2 and 3, T. 29 N., R. 11 W., MDM. was not examined, but the deposit is reported (oral communication, C. E. Collins, 1943) similar to that of the Low Gap claim.

Boyer Group (89)

The Boyer group of mines consists of three claims—the September Morn and July Nos. 1 and 2—on the slope of a small gulch on upper Hayfork Creek in NE¼ sec. 9, T. 29 N., R. 11 W., MDM. It is accessible by about 1½ miles of spur road from the Forest Service road along the upper part of Hayfork Creek. The trucking distance to Red Bluff is about 70 miles. The claims are owned by Dave Boyer, and were leased by John Dreskthorp of Redding.

The main workings, on the September Morn claim, consist of an open cut that leads into a drift 50 feet long. Bulldozer cuts were made on the July No. 1 claim but ore was not uncovered.

Most of the ore of the September Morn was mined and shipped. It apparently occurred as stringers in sheared serpentine. In September, 1943, a small amount of ore still was in place in the back of the drift for about 25 feet from the portal. The ore strikes N. 70° W. and dips 60° S. A small cut above the face of the drift exposed a small amount of ore and indicates that a few more tons of ore could be mined from the deposit. About 100 long tons of ore were reported (oral communication, John Diestelhorst, 1943) to have been shipped from the deposit, and 2 or 3 tons remain on the dump. The only recorded production is 63.7 long tons of ore which was shipped to the Metals Reserve stockpile at Anderson in 1942; the ore assayed 47.56 percent Cr_2O_3, 14.5 percent Fe, and had a Cr Fe ratio of 2.24.

HUMBOLDT COUNTY

Humboldt County occupies approximately 3,500 square miles between Trinity County and the Pacific Ocean. It is bounded to the south by Mendocino County; the county line is almost coincident with the 40th parallel. The northern boundary, from the Pacific Ocean 16 miles eastward, is formed by Del Norte County and east of this by Siskiyou County.

Eureka, the county seat and commercial center, is on Humboldt Bay. It is served by coastal shipping, the Northwestern Pacific Railroad, and U.S. Highway 101. Steep paved highways follow the river valleys

and cross the intervening ridges at a few places, but the mountains between are mostly accessible only by Forest Service and logging roads and trails.

The climate near the coast is mild and moist. Inland the winters are rainy and the summers dry. Snow several feet in depth on the ridges makes hauling difficult or impossible during the winter.

The geology of the county has been mapped in reconnaissance by Irwin (1960), who published a map showing the distribution of the large rock units, including the ultramafic rocks.

Most of the chromite production has come from four principal bodies of peridotite in the northeastern part of the county. The Horse Mountain body is in the central part of the county. It is lenticular in form and about 4 miles long. The peridotite bodies have not been mapped in detail.

History and Production

The chromite deposits of Humboldt County received little attention from prospectors until 1918 when the high price due to the Federal Government's program to increase production started a search for chromite.

The difficulties of freighting chromite out of this area during World War I are clearly revealed by the following quotation from the Eureka, California, Standard on July 5, 1918.

"Some idea of the value of the Pecwan ore may be gathered from the expensive handling it must undergo to get it onto the cars here where it is paid for. In the first place, after being mined it is sacked and packed on mules, eight miles to the Klamath River near Johnson's, thence Indians transport it 22 miles down the river in canoes, a few sacks to a canoe, to the wharf at Requa where wharfage must be paid. From Requa it is brought here by gasoline schooner, about 25 tons to the cargo, and once more wharfage must be paid and it must be handled, for it has to be unsacked and dumped into the railroad car."

In 1918, a total of 136 long tons was produced from this county (Table 11), but interest in chromite ceased with a collapse of prices. Mining was renewed in 1941, and some ore was shipped each year

Table 11. Chromite production from Humboldt County, California, as of 1957 (in long tons).

Property	1918	1941	1942	1943	1944	1954	1955	1956	1957	Total
Big Rock (Red Gap)				73						73
Binder No. 1							5			5
Blue Creek Tunnel							24			24
California Chrome Co.				134						134
Demight				49						49
Eureka				27						27
Horse Mountain	63									63
Lassic Peak						3				3
Little Annie				3						3
Man O'War				48						48
Pecwan	73									73
Pyramid						20	56			76
Rivers, Joe		577	1,363	523	289					2,952
Twin Lakes									30	30
White Cedar						78	71	86	50	285
Wilder (Fish Creek)			78	67						145
Total	136	577	1,641	924	289	101	156	86	80	3,990

Table 12. Alphabetical list of chromite mines and prospects in Humboldt County, California, giving old names, locations, owners, and operators.

Name of mine or prospect	Map no.	Location (MDM)			Name of owner (O) or shipper (S)	Source of data	Class[1] by production
		Sec.	T.	R.			
Big Rock mine	93x	24	10N	4E	J. L. Woodhouse (S)	Wells, F. G., 1945, unp.	C
Binder No. 1					J. S. Folsom	U. S. B. M.	--
Blue Creek tunnel					R. H. Ellison	U. S. B. M.	--
Burrill Peak	94x	27	10N	4E	L. M. Bryant and Bros. (S)	Wells, F. G., 1945, unp.	D
California Chrome						Division of Mines files	C
Denight						Division of Mines files	C
Enreka						Division of Mines files	C
French Camp prospect	95o	22	9N	3E			--
Horse Mountain	96o	33, 34	6N	4E	H. R. Sanborn and A. B. Weaver (O)	Averill, 1941, p. 505; Wells, F. G., 1951, unp.	C
Lassic Peak					C. F. Starr (S)	U. S. B. M.	C
Little Annie							C
Man of War					Griffith Mining and Develop. Co. (S)	Division of Mines files	C
Onion Mountain prospect	90x	5	11N	4E			--
Pecwan mine (Englebright, New Moon)	87x	36	12N	3E	A. E. Englebright and B. A. Marsh (S)	Rynearson, G. A., 1943, unp.	C
Porter Ranch	97x	32	3N	4E			--
Pyramid					R. N. Ellison	U. S. B. M.	C
Red Gap	92x	8	10N	6E			--
Rivers group	89x	2	11N	4E	H. A. Rivers (O); D. R. Moroney (S)	Wells, F. G., 1942, unp.	A
Signal Peak Nos. 1, 2, 3, 4, and 5	99o	SE 36	1S	5E	A. C. Crossman, Jack Doyle, and Tom Tyree (O)		--
Twin Lakes						U. S. B. M.	C
White Cedar	88x	36	12N	3E	Dan Haight	U. S. B. M.	B
Wilder mine (Fish Creek, Man O'War)	91x	11	11N	4E	L. O. Wilder (S)		C
Wood	98x	3	1N	4E			--

[1] A—1,000 long tons or more.
B—150–1,000 long tons.
C—Less than 150 long tons.
D—No ore shipped.

from 1941 to 1943 and from 1954 to 1957. Total production from the county is 3,990 long tons (1957).

The chromite mines and prospects that have been reported in Humboldt County are listed in Table 12.

Beach Deposits

For many decades, it has been known that the sands of some of the northwestern beaches contain significant amounts of chromite, in addition to other heavy minerals. These heavy minerals (commonly called black sand) are concentrated into streaks along the beaches by the action of the surf, especially during the waning of southwesterly storms. These streaks range greatly in length, width, and thickness, but commonly are only a few inches thick, a few feet wide, and several yards long. Day and Richards (1906, p. 1184–1185) generally found 20 pounds or more of chromite per ton of beach sands from Gold Bluff and Trinidad, and as much as 620 pounds per ton in a sample, obviously from a rich streak, 3 feet below the surface of the beach at Trinidad. It is questionable whether the rich streaks are sufficiently large and numerous for profitable exploitation, but it is possible that the whole beach might be considered a low-grade source of chromite. An important consideration in estimating the value and extent of any alluvial deposit is careful and systematic sampling either by sinking pits at regular intervals or drilling with some satisfactory type of churn drill. Until this is done, the value of the beaches as a source of chromite can not properly be evaluated.

Blue Creek Mountain Area

A rudely elliptical peridotite body forms the high land in T. 12 N., R. 3 E., HM, along the boundary between Humboldt and Del Norte Counties. It extends northward almost to Blue Creek, is 7 miles long and 4 miles wide. Its shape and position suggest it to be an anticlinal structure like the peridotite at South Red Mountain a few miles to the northwest (Wells and others, 1946, p. 71). Two occurrences of chromite, the Peewan mine and Onion Mountain prospect, are reported in it.

Peewan Mine (Englebright, New Moon) (87)*

The Peewan mine is near the county boundary on Peewan Creek. It was operated by A. E. Englebright and B. A. Marsh during 1918, when 73 tons of ore, having a grade of 42 percent Cr_2O_3, are reported to have been shipped. Additional ore may have been mined and shipped, but records are conflicting. The property is reached by 8 miles of steep trail from the Johnson place on the Klamath River.

Onion Mountain Prospect (90)

An occurrence of chromite is reported north of Onion Lake in sec. 5, T. 11 N., R. 4 E., HM. In 1950, a Forest Service road in poor condition could be traveled in a jeep from Bluff Creek Guard Station on the Klamath River as far as Bee Mountain. From this point the prospect could be reached by 7 miles of trail. The prospect was not visited by the writers.

* Numbers following mine names refer to map, Plate 19.

Fish Creek Butte Area

An elongate body of peridotite in T. 11 N., R. 4 and 5 E., HM, extends southward from Del Norte County into Humboldt County, a distance of 6 miles. It ranges in width from ½ mile to about 2 miles, and occupies the crest and part of the east slope of Fish Creek Butte. Ore was mined from three chromite occurrences, the Wilder property (91) * and two claims of Joe Rivers. They are accessible by a steep road that leaves the Klamath River road 3 miles west of Orleans and climbs 3,500 feet in 4 miles.

Wilder Mine (Fish Creek, Man O'War) (91)

The Wilder claim is in sec. 11, T. 11 N., R. 4 E., HM, at an altitude of 3,750 feet, and 1 mile from the Flint Valley Forest Service road. When visited in September 1944, the deposit appeared to be mined out. A total of 145 long tons of ore was shipped during 1942 and 1943. It assayed 40 percent Cr_2O_3.

Rivers Group (89)

The Rivers group of claims, held by Joe Rivers, is in sec. 2, T. 11 N., R. 4 E., HM, between altitudes of 4,100 and 4,500 feet. It is 21 miles by Forest Service dirt road from the Klamath River. The property was leased in 1941 and 1942 by Mrs. D. R. Moroney, who shipped 2,140 long tons of ore. During 1943 and 1944, the Metals Reserve Co. reported that they received 812 long tons of chromite consigned from this property by Mrs. Moroney, Pettigrew, and H. E. Ellickson, making a total production of 2,952 long tons.

The ore was developed by a large open stope. The country rock is serpentinized but unsheared saxonite, with irregular streaks of dunite running through it. It is cut by two sets of small faults; one set strikes N. 30° E. and dips 30° NW; the other set strikes N. 30° W. and dips 65° NE. The ore body is tabular, and strikes N. 25° W. within one of the streaks of dunite. The ore ranges from almost solid chromite through disseminated ore to barren dunite and must be sorted to obtain a shipping grade.

Red Gap Claims (92)

The Forest Service reported this claim in SW¼ sec. 8, T. 10 N., R. 6 E., HM. It is in a narrow band of slickentite that strikes a few degrees east of north and separates diorite on the east from the Galice Formation on the west. In 1943, the Metals Reserve stockpile received 73 long tons of chromite ore from this property shipped under the name "Big Rock."

French Camp Prospect (95)

The French Camp prospect is on the road from Weitchpec or Orick, in sec. 22, T. 9 N., R. 3 E., HM. Sloughed trenches and scattered pieces of chromite are the only evidence of mining done here during World War I. The trenches are in slickentite.

Horse Mountain Claims (96)

A lenticular body of peridotite crops out for 6 miles from just south of U.S. Highway 299 between Arcata and Willow Creek to Black Rock. It has a maximum width of 1½ miles and forms the crest of the ridge

dominated by Horse Mountain. The peridotite is regionally serpentinized and is cut by dikes, 5 to 15 feet in width, that are composed of unusually large crystals of hornblende and pyroxene with minor amounts of plagioclase feldspar. Crystals of hornblende as large as 2 feet in length are seen, as well as pyroxene crystals as much as several inches long.

Discovery of rich copper float on Horse Mountain about 1900 led to the staking of many claims, and to some development by the Horse Mountain Copper Co. The claims are in secs. 33 and 34, T. 6 N., R. 4 E., HM. The development work uncovered two deposits of chromite, and 63 tons of chromite ore were shipped in 1918. In 1941 the property was owned by H. R. Sanborn and A. B. Weaver.

The area is accessible from Eureka by 39.3 miles of U.S. Highway 299 and 4.2 miles of steep mountain road. The two deposits are about 2 miles apart on the rounded crest of the mountain at an altitude of 4,600 feet. At the northerly deposit, an irregular caved pit 115 feet long and 20 to 40 feet wide, trends from S. 80° E. to S. 45° E. At the southern deposit, a caved pit 30 feet in length with a caved incline shaft near its center trends S. 20° W. The chromite bearing material scattered about the dump is mostly low grade and shows a peculiar "egg" structure of smoothly rounded elliptical nodules of chromite enclosed in serpentine. Apparently the deposit was not mined during World War II, as there was no evidence of recent work when the property was visited in 1951.

Signal Peak Claims (99)

Five claims, the Signal Peak claims Nos. 1, 2, 3, 4, and 5, were located by A. C. Crossman, Jack Doyle, Tom Tyree, and George Kniss in SE¼ sec. 36, T. 1. S., R. 5 E., and N½ sec. 30, T. 1 S., R. 6 E., HM. They are on a ridge dominated by the three clustered peaks, Red Lassic, Black Lassic, and Mt. Lassic, formerly Signal Peak, altitude 5,872. When visited in 1942, the claims were reached by about 2 miles of trail from the end of the Lassic Lookout Forest Service road which leaves the county road at Zenia between Bridgeville and Hoaglin Guard Station.

The country rock is highly serpentinized and sheared saxonite which interfingers into the metasedimentary rocks that comprise the Lassic peaks area. A few tons of float ore are scattered over several claims; the largest piece observed weighs about 500 pounds. Three shallow trenches were dug, but ore was not found in place. Apparently the massive chromite has come from several small pods and has weathered out of the serpentine. A composite grab sample taken from several piles of float contained 59.68 percent Cr_2O_3. Some of the chromite contains a small amount of interstitial serpentine, so that the pure chromite contains slightly more than 60 percent Cr_2O_3.

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EXPLANAT

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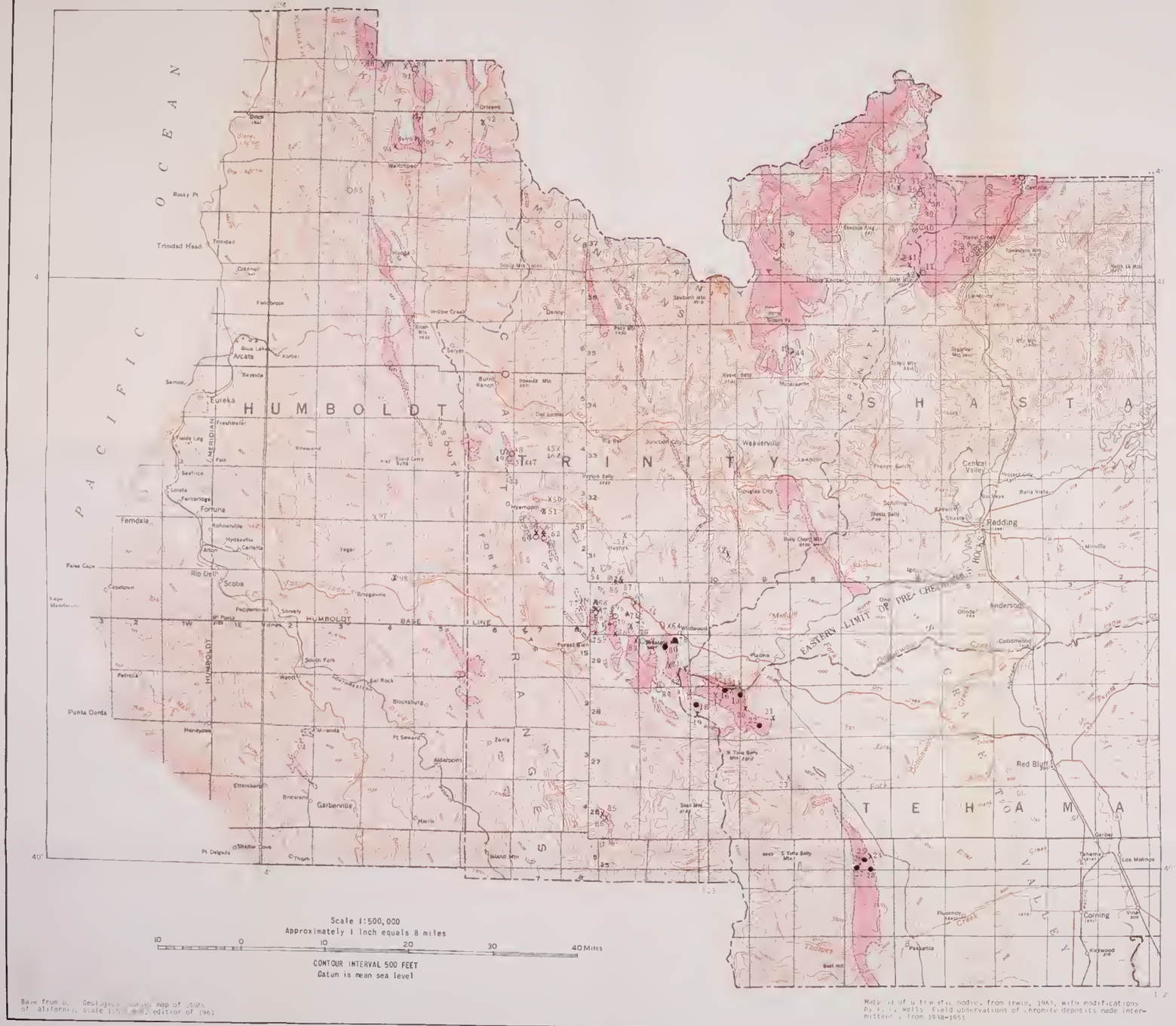

Base from U. S. Geological Survey map of State of California, scale 1:500,000, edition of 1961

Mapping of ultramafic rocks, from Irwin, 1963, with modifications by F. G. Wells. Field observations of chromite deposits made intermittently, from 1938-1951

EXPLANATION

Outcrop of ultramafic rocks

Chromite deposits accurately located
Solid circle represents several mines or prospects

Chromite deposit located by description
Numbers refer to alphabetical lists in the text and to the accompanying list of chromite deposits. Some deposits are located in outcrops of ultramafic rock too small to be shown at this map scale

LIST OF CHROMITE DEPOSITS

Mines and prospects

SHASTA COUNTY

1 Little Castle Creek (Brown) mine
2 Hearst lease
3 Lucky Strike
4 Lone Pine
5 Shotgun Creek (Noble Electric)
6 Myles and Westover
7 Hoy
8 Forest Queen (Gray Eagle) group
9 Davis group (Ida Chrome group)
10 Cantonwine (Hilt lease)
11 County line claim (Wildcat Creek)

TEHAMA COUNTY

12 Cadillac
13 Little Red Mountain group
- Blue Sky
- Blue Jay
- Jumbo (Red Mountain No. 2)
- Live Oak
- McArthur and Lucky Star
- Mogul
- Name unknown
- Panther
- Seagrave (Beegum mine)
- Snowshoe
- Sunsatne (Red Mountain No. 1, Pine Grove)

14 Bumble Bee
15 Bear Cat
16 Zachary group:
- Beegum Nos. 3, 4, and 5
- Beegum Nos. 6, 7, and 8
- Black Jack
- Red Bird
- Three Point Buck

17 Round Bottom
18 Turner group:
- Peach, Buella A.
- Twin Cedars

19 Bland (Packsaddle, Bonner)
20 Utah Chrome
21 McArthur
22 Tedor group:
- Dead Pine claim
- Mountain View claim

23 Tomshead
24 State lease
25 North Elder Creek group:
- Grau
- Grau, West pit
- Hill
- Joyce
- Mill Gulch
- Noble Electric, Lower
- Noble Electric, Upper
- Name unknown
- No name

26 Big Bear
27 Thorn group:
- Ore Basin
- Valley View

28 Kleensorge group:
- Angora
- Black Beauty
- Climax
- Melton
- Name unknown
- Name unknown
- Trilby

TRINITY COUNTY

29 Picayune Lake group
30 Tangle Blue Divide
31 Green Stripe Chrome mine
32 Railroad lease (Section 11 mine)
33 Mumbo Creek group
34 Charlene Sue
35 Section 11 (Crow Creek group, McConnell-Kirby, Chapman-Kirby)
36 Costa claim (Tyler Lily)
37 Integral (Cinnabar) mine

TRINITY COUNTY--continued

38 Summit
39 Pink Crystal (Costa lease)
40 Copper King
41 Wildcat Chrome
42 Chrome
43 Mule Creek
44 Beagdon
45 Black Bear
46 Dry Ridge
47 Ellapon
48 Stanton Chrome, Stanton Chrome Extension
49 Jeffery Pine
50 Pallestreau
51 Schules
52 Schreckengost group
53 Phillpot
54 Little Ann Chrome and Munsie A Chrome mines
55 Maringer mine
56 Tule Creek
57 Lost Dog mine
58 McKay and Abbott
59 Vance group
60 Sangra La
61 Chrome No. 1
62 Happy Go Lucky
63 Yellow Pine
64 Old Bones
65 Lost Horse
66 Eureka
67 Western Chrome No. 1
68 Western Chrome No. 3
69 Compass
70 Power Claim
71 Bloody (Surprise)
72 Buster and Cuff
73 Black Jack
74 Western Chrome No. 1
75 Empire
76 Federal
77 Heelling claims
78 Collins group:
- Cedar Nos. 1, 2, 3, and 4
- Chrome Center
- Dry Cedar
- Five O'Clock
- Green Chrome
- Iridium
- Junction No. 1
- Junction No. 2
- Junction Extension
- Low Gap
- Pride of Trinity
- Rattlesnake
- September
- Summit Nos. 1 and 2
- Sunnyslope
- Sunnyslope No. 2

79 Gray Fox (Roosevelt)
80 Boyer groups
- July 1 and July 2
- September Morn

81 Compton
82 I Wonder
83 Brown Bear
84 Evelins (Dry Camp)
85 Grubstake
86 Red Mountain

HUMBOLDT COUNTY

87 Pecwan mine (Englebright, New Moon)
88 White Cedar
89 Rivers group
90 Onion Mountain prospect
91 Bolder mine (Fish Creek, Man O'War)
92 Red Cap
93 Big Rock mine
94 Barrell Peak
95 French Camp prospect
96 Horse Mountain
97 Porter Ranch
98 Wood
99 Signal Peak Nos. 1, 2, 3, 4, and 5

MAP SHOWING AREAS OF ULTRAMAFIC ROCK AND LOCATION OF CHROMITE DEPOSITS IN SHASTA, TEHAMA, TRINITY, AND HUMBOLDT COUNTIES, CALIFORNIA

BY
F. G. WELLS AND H. E. HAWKES
1963

utcrop of chromite ore

ault on first level

on third level showing dip

Shear zone

trike and dip of beds

d lineation of disseminated ore

of open cut or slumped area

Dump

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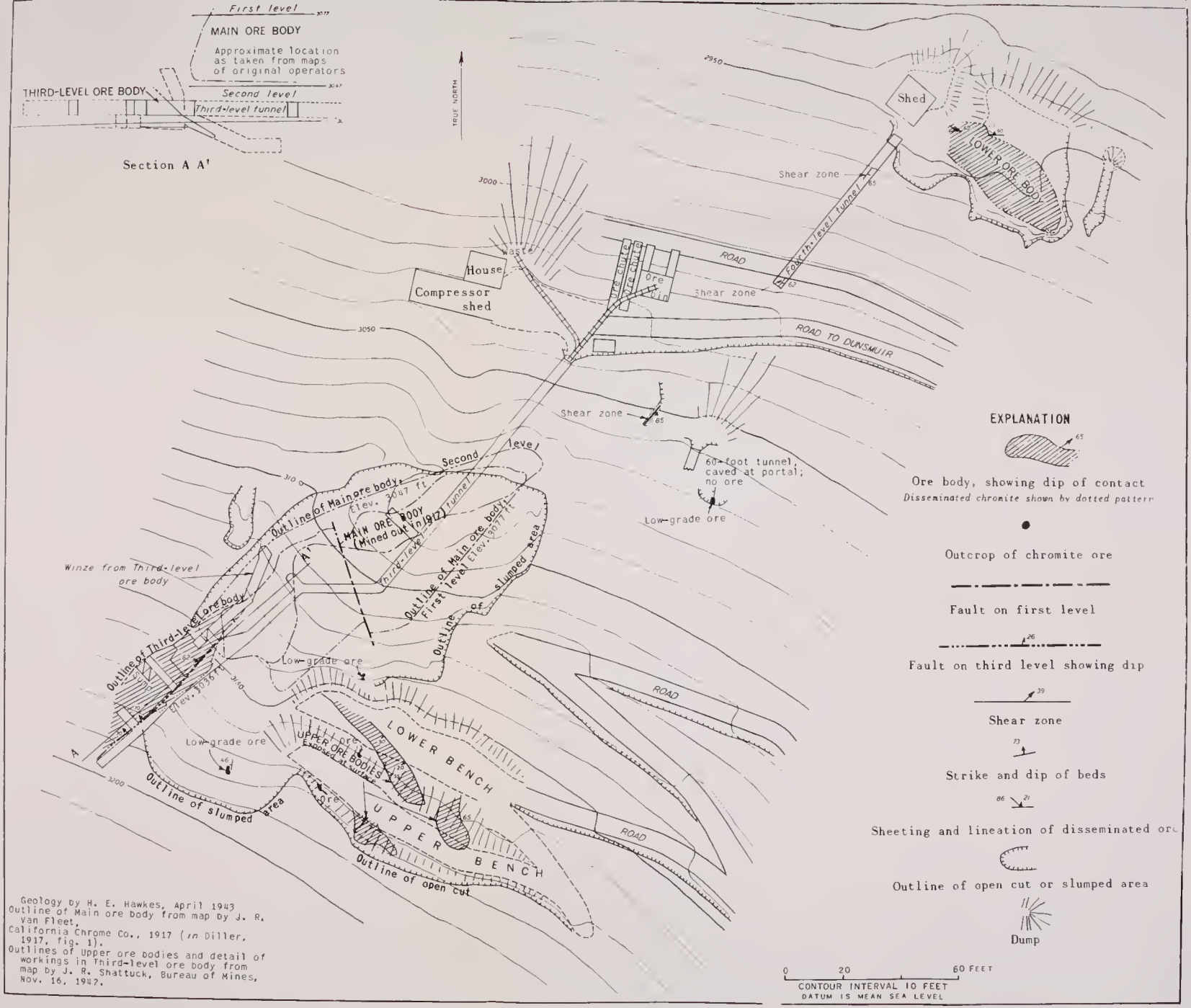

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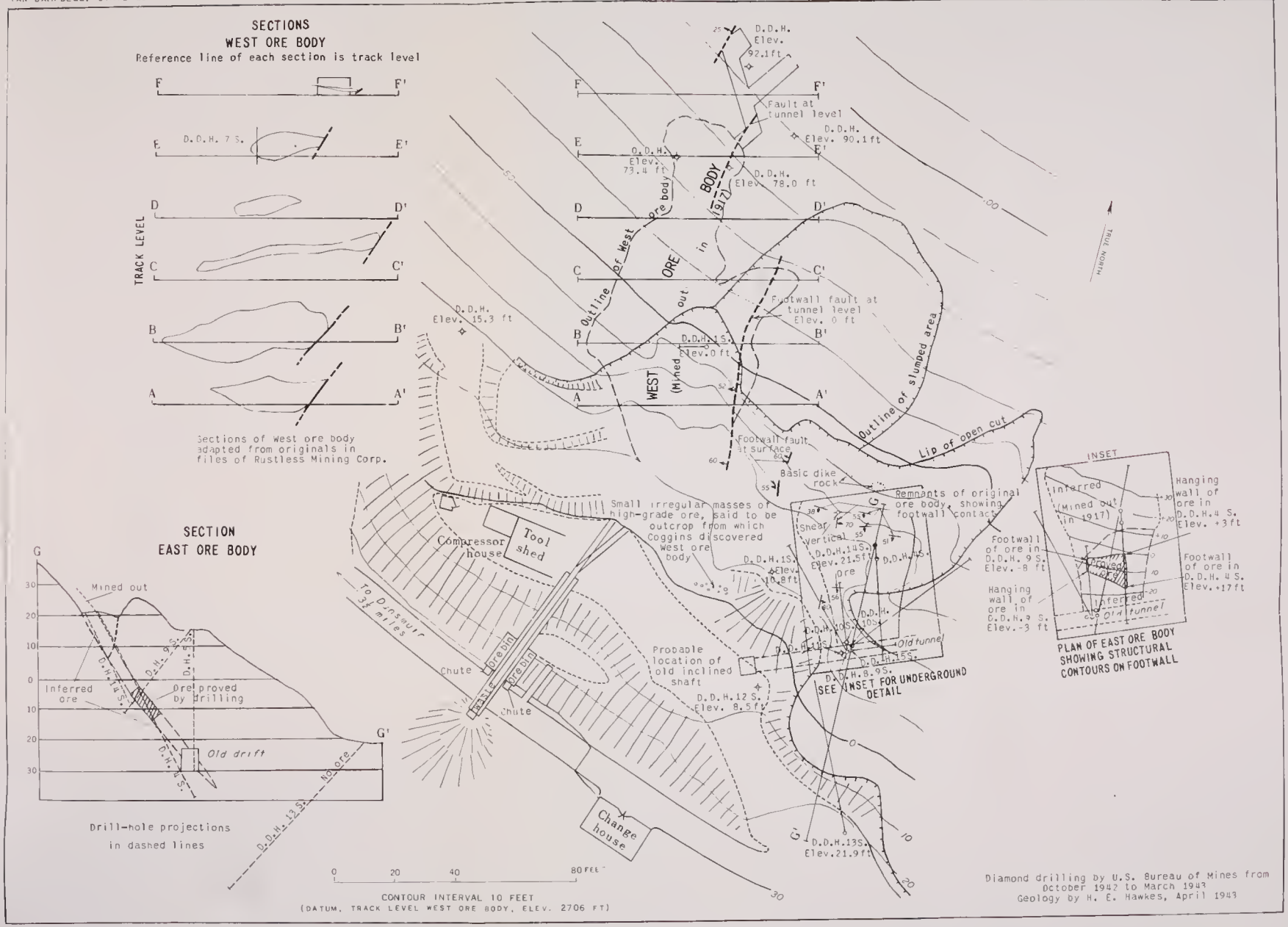
Outline of Main ore body from map by J. R. Van Fleet, California Chrome Co., 1917 (*in* Diller, 1917, fig. 1).
Outlines of Upper ore bodies and detail of workings in Third-level ore body from map by J. R. Shattuck, Bureau of Mines, Nov. 16, 1942.

SURFACE AND UNDERGROUND PLAN AND SECTION OF THE LITTLE CASTLE CREEK MINE, SHASTA COUNTY, CALIFORNIA



PLAN AND SECTIONS OF WEST AND EAST ORE BODIES, COGGINS MINE, SISKIYOU COUNTY, CALIFORNIA

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